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THE GROWTH AND DECAY OF TURBULENT MIXING IN THE PLANETARY BOUNDARY LAYER

R. S. Sholtes

Florida University

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April 1972

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The Growth and Decay of Turbulent Mixing in the Planetary Boundary Layer

Office of Research and Monitoring
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16. Abstracts The report describes a study which was performed in order to examine the development and collapse of mixing layers with particular emphasis upon the latter using aircraft motion due to air turbulence as the primary measured quantity. Variations in this process which might be attributed to cloud cover, urbanization, wind patterns and other meteorological parameters were sought. Toward this end data were collected in several meteorological patterns and in one urban (Atlanta) and one rural (Gainesville, Florida) setting. Data were gathered by making vertical soundings with an instrumented aircraft and recording signals that would furnish measures of the mixing height and a function of turbulent energy levels therein. Thus altitude, temperature and lateral acceleration of the aircraft were sensed and recorded simultaneously. The RMS value of the aircraft lateral acceleration was also monitored and recorded, thereby serving as an atmospheric turbulence indicator. The results and conclusions are presented.

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Turbulence
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Meteorology
Urban areas
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Aircraft turbulence

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The Growth and Decay of Turbulent Mixing in the Planetary Boundary Layer

by

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Prepared for

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THE GROWTH AND DECAY OF TURBULENT MIXING IN THE PLANETARY BOUNDARY LAYER

INTRODUCTION

It has been wisely said that a problem well understood is well on the way to a solution. In the field of air pollution control, it is safe to conclude that a firm understanding is yet to be obtained. Through the efforts of many investigators progress is steadily being made in understanding this widespread and complex problem.

A small but significant part of this effort is that of understanding the mechanisms of dispersion and mixing of pollutants in the lower atmosphere.

In work preceding this[1] considerable effort was expended in examining methods of predicting daily mixing heights using early morning radiosonde observations of the vertical temperature structure. The method described by Holzworth[2,3] was essentially verified for most daytime hours. In as much as the method is based upon a redistribution of heat imput to the ground, it would not be surprising to

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[1] McCaldin, R. O. and R. S. Sholtes, "Mixing Height Determinations by Means of an Instrumented Aircraft." Final Report N.A.P.C.A. Research Contract No. CPA 22-69-76, June, 1970.

[2] Holzworth, G. C., "Mixing Depths, Wind Speeds, and Air Pollution Potential for Selected Locations in the U.S." Journal of Applied Meteorology, Vol. 6, No. 6, December, 1967, pp. 1039-1044.

[3] Holzworth, G. C., "Large-Scale Weather Influences on Community Air Pollution Potential in the U.S." Journal of the Air Pollution Control Association, Vol. 19, No. 4, April, 1969, pp. 248-254.

suspect that its predictiv value would be limited in the late afternoon when temperatures and radiant energy input rapidly decrease. The work described by McCaldin and Sholtes[1] suggested such a phenomena as illustrated in Figure 1, reproduced from that report. These data suggest an orderly buildup of the mixing height followed by a relatively extremely rapid decrease or collapse prior to sunset. Examination of the figure will reveal that one method of determining the upper limit was labeled "aircraft turbulence". This method was based upon sensing the lateral acceleration of the experimental aircraft; a measure which exhibited a dramatic change upon passage from the turbulent layer upward into the undisturbed air mass above. While reducing the data to construct figures such as Figure 1, the authors noted a definite decrease in the amplitude of the lateral acceleration record as the mixing layer or zone experienced the late afternoon rapid decrease or collapse. These observations suggested further investigation of this time period using some technique involving the aircraft lateral acceleration, as an indicator of mixing vigor.

OBJECTIVES

This project was performed in order to examine the development and collapse of mixing layers with particular emphasis upon the latter using aircraft motion due to air turbulence as the primary measured quantity. Variations in this process which might be attributed to cloud cover, urbanization, wind patterns and other meteorological parameters were sought.

Toward this end data were collected in several meteorological patterns and in one urban (Atlanta) and one rural (Gainesville, Florida) setting. The area of Atlanta used was densly populated with considerable industry and a high percentage of the surface area covered by man made structures. The Gainesville site on the other hand was essentially vegetative surface coverage distant from any population center.

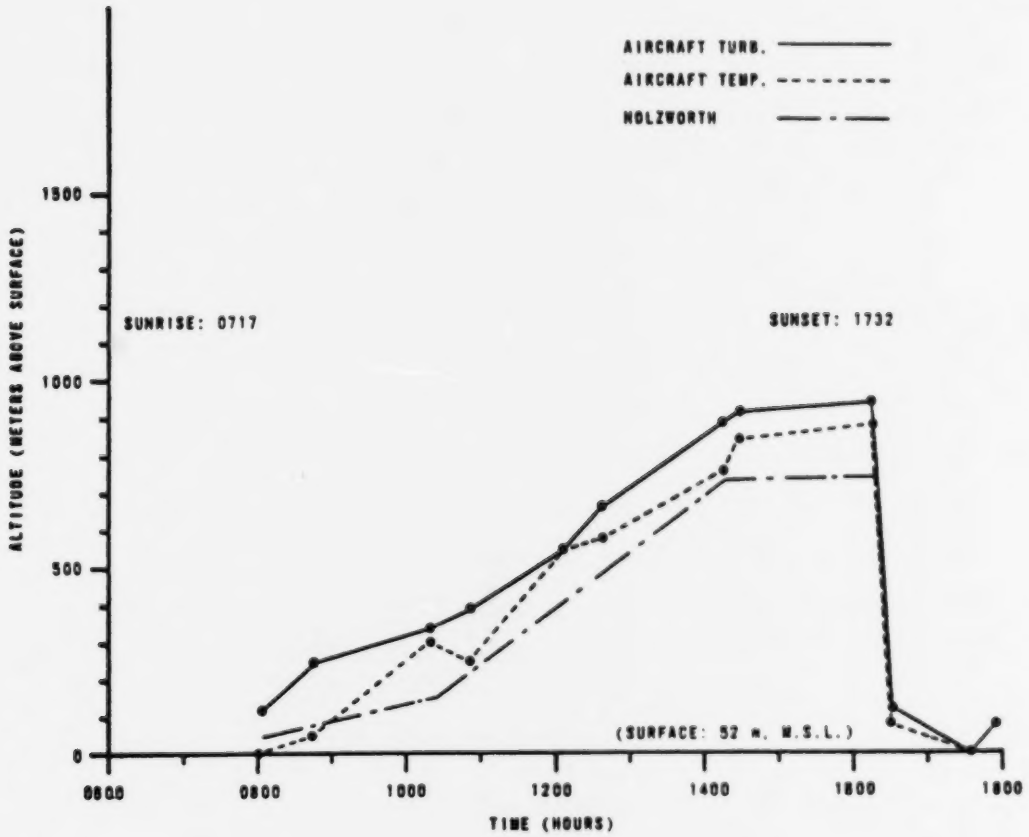

FIGURE 1

DEVELOPMENT IN MIXING HEIGHT DURING COURSE OF DAY - AS DETERMINED BY SEVERAL METHODS. GAINESVILLE, FLA. 10 DEC. 1970

METHODS

Data were gathered by making vertical soundings with an instrumented aircraft and recording signals that would furnish measures of the mixing height and a function of turbulent energy levels therein. Thus, altitude, temperature and lateral acceleration of the aircraft were sensed and recorded simultaneously.

As will be explained later, the RMS value of the aircraft lateral acceleration was monitored and recorded in addition to the aforementioned three; this value serving as an atmospheric turbulence indicator. These parameters as measured are illustrated in Figure 2.

Basic to the recording of mixing height phenomenon is a reliable indicator of altitude. These data are illustrated on Figure 2, whereupon it would seem that the aircraft went aloft in a stepwise fashion. This appearance is due to the pressure transducer construction and does not interfere with good altitude resolution. As indicated this part of the instrumentation is directly readable in thousands of feet above ground level (AGL).

Trace #1 illustrates the temperature profile found by the instrumented aircraft during an afternoon sounding. Using the temperature profile, the mixing height is the first point above the surface at which the profile becomes isothermal (3400 ft AGL in this case).

Trace #2 illustrates the form in which the aircraft lateral acceleration is recorded. Signal variations represent yaw and lateral

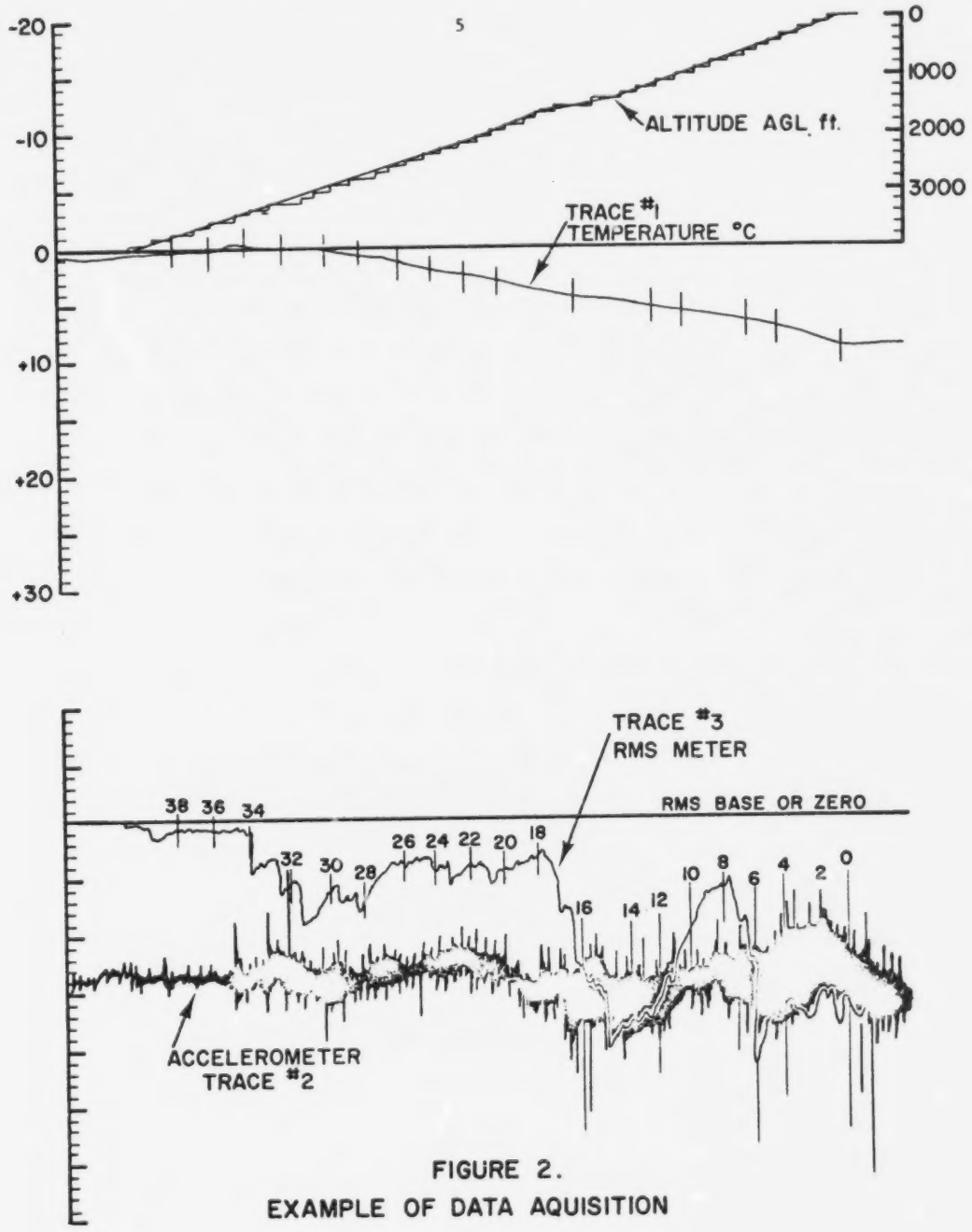

FIGURE 2.
EXAMPLE OF DATA AQUISITION

acceleration experienced by the aircraft; frequency and amplitude of the trace is considered to be an indicator of atmospheric turbulence[4]. In the mixing layer this turbulence was sufficient to cause lateral aircraft accelerations on the order of 0.1 g. Above the mixing layer the engine vibration produced an acceleration of about 0.02 g. Thus, there was found to be on the order of a five-fold difference in accelerometer amplitude below and above the mixing height. In most cases, a rather well-defined delineation between the two zones existed. Using lateral acceleration the mixing height is the altitude where this transition occurs (3500 ft in Figure 2).

Trace #3 derives directly from this accelerometer trace and is simply the RMS value thereof, determined electronically using a ten second averaging time. For convenience altitudes AGL are manually superimposed upon this trace.

Franz conducted extensive experiments[4] in which these RMS values were correlated with ground based measurements of the lateral component of the wind as measured by a wind vane. He concluded that the RMS of the aircraft accelerometer output was proportional to atmospheric turbulence and therefore could be used as an atmospheric turbulence indicator. It should be emphasized that these indications are relative one to another since it was not possible to obtain a calibration.

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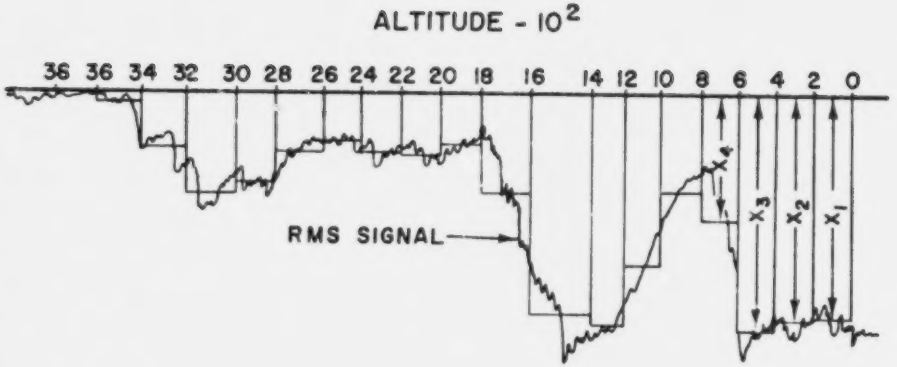
[4] Franz, J. J., "Aircraft Accelerometer Studies for Mixing Height Determinations." M.S. Thesis, University of Florida, June, 1970.

Using this turbulence indicator, the mixing height is the altitude where its value approaches its base or zero level (3500 ft in Figure 2).

Figure 3 illustrates the method of reducing each RMS sounding to useable form. Due to the nature of an actively mixing layer, the turbulence indicator levels are anything but constant. A system was therefore developed whereby the RMS or turbulence indicator trace was divided into 200 foot altitude intervals within which the average value was visually established by drawing a horizontal line at the average amplitude. This series of values was then integrated over the entire mixing layer for that day and time. The upper limit of the mixing height was taken as that elevation (AGL) at which the RMS signal returned to the zero or baseline level.

Satisfactory soundings of the atmosphere were made on 15 days during the period of 15 October, 1970 through 15 December, 1971. On each day, repetitive soundings were made in order to follow the temporal development of the mixing height with emphasis on the late afternoon period. Flight speeds were generally 90 mph (IAS). One crew member flew the aircraft while the other operated instruments and made appropriate notations.



$$\text{TURBULENCE INDICATOR} = \left(\sum_{i=1}^{n} x_i\right)(200\,\text{ft.})$$

FIGURE 3.

DETERMINATION OF TURBULENCE INDICATOR

EQUIPMENT

A Cessna 172 (Skyhawk) aircraft was used for this activity[5]. The only aircraft modification involved the installation of a larger than normal alternator to provide the needed power for the instrument package.

The instrument package with its several components was approved by the FAA for restricted category operation. Basically, these restrictions limited operation to daylight hours and no more than a two-person crew.

As installed, the instruments were capable of measuring eight parameters, although only four were used in this study. As previously indicated, the variables recorded were altitude, lateral acceleration, temperature, and RMS of acceleration; all recorded simultaneously on a null-balance potentiometric recorder.

All equipment was designed to operate on 110 volt 60 cycle current. Power was made available through two inverters operating from the aircraft 12 volt DC system. Altitude was determined by using a potentiometric absolute pressure transducer acting in a voltage divider network. Excitation was provided by a regulated power supply. The output from the transducer was fed directly to the recorder. An adjustable zero was provided on this channel of the recorder to accommodate barometric pressure changes, adjustments being made at the beginning of each flight.

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[5]McCaldin, R. O., and Johnson, L. W., "The Use of Aircraft in Air Pollution Research." J.A.P.C.A., Vol. 19, No. 6, June, 1969, pp. 405-409.

Temperature was measured with a linear response thermistor network situated in a DC bridge circuit. These circuits proved reliable, but did suffer from component temperature sensitivity. Response time of this element was on the order of five seconds or less.

Aircraft acceleration was sensed by a potentiometric type yaw accelerometer rigidly fixed to the airframe. The total range of this instrument is $\pm$ 0.33 g. Its excitation was through a regulated DC power supply and the output fed directly to the recorder.

RMS values of the above accelerometer signal were derived and provided for recording purposes by a Thermo-System RMS voltmeter. This instrument provided many time average selections; for this study, the 10 second option was found to be optimal.

As indicated, all variables are routed to a null-balance potentiometric recorder. This unit has four channels, thereby allowing all variables to be simultaneously recorded on a single chart. Chart speed for this work was standardized at 1 inch per minute. Ground meteorological instruments were located at Gainesville Airport and Fulton County Airport, Atlanta. Among the observations recorded by the FAA stations at these sites are Total Sky Cover and Total Opaque Sky Cover, the latter being of particular interest in this study. These observations are defined as follows:

> Total Sky Cover - The amount, in tenths, of the entire sky that is covered (total sky cover) or hidden (total opaque sky cover) by layers at and below a given level. This amount cannot be greater than 1.0.

Opaque Sky Cover - The amount (to the nearest tenth) of cloud layers or observing phenomena (aloft or surface-based) that completely hides all or a portion of the sky and/or higher clouds that may be present.

FINDINGS AND DISCUSSION

Since the sampling method and extent of soundings resulted in such an array of data for each day it was decided to group all data for an individual day together. Discussion of each set of data is located with the data rather than in a continuous text. Generally these data clearly show that the atmospheric turbulence and height of mixing undergo a very rapid decrease in the hours prior to sunset. Cloud cover and rainshowers will influence these phenomenon by upsetting the energy input to the surface and in the case of rain by the additional mechanism of direct cooling.

For each of the 15 satisfactory days of experimentation, two figures are presented which contain the following:

a) Turbulence indicator vs time of day as determined using the procedure described by Figure 3.

b) Surface temperature vs time of day as recorded hourly by the local FAA station.

c) Sky opacity vs time of day as observed and defined by the local FAA station.

d) Surface wind velocity and direction as recorded by the local FAA station.

e) Turbulent mixing height vs time of day as determined from aircraft data using only ascents.

September 13, 1971

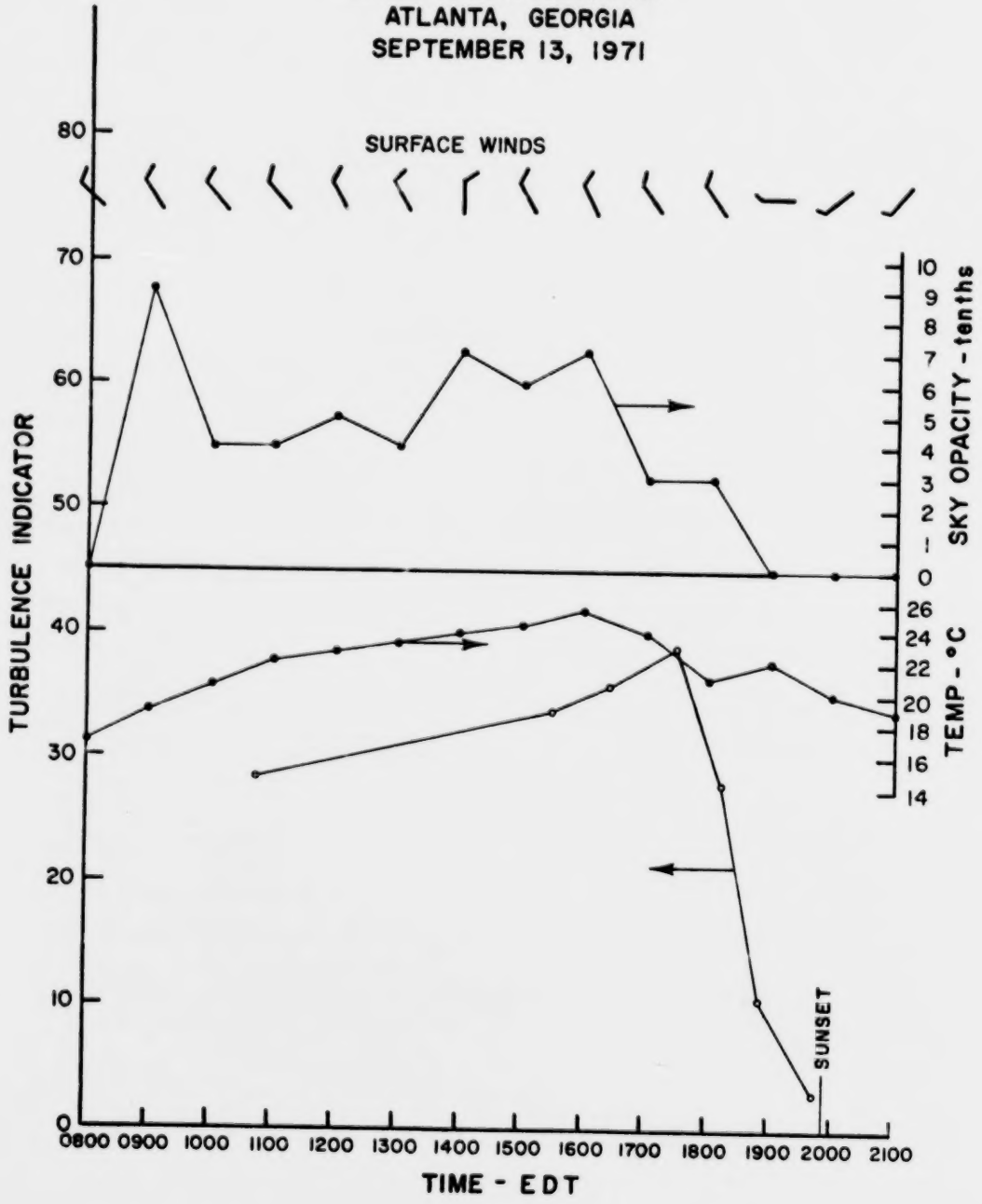
The weather of September 13, 1971 in Atlanta was dominated by a polar continental air mass and dew points were running in the fifties. A weak cold front had passed Atlanta the morning of the 12th, and another weak cold front was approaching from the northwest. This second front passed through Atlanta late in the afternoon on the 13th. Upper winds were north-westerly carrying in dry air; up to 18,000 feet.

The temperature regime in Atlanta for this date ranged from a high of 78 to a low of 58. No precipitation occurred in Atlanta during the 24-hour period, however, considerable precipitation existed to the north and northeast of this area.

Locally the mixing behavior was somewhat typical having a buildup then rapid collapse. The sky cover of 0.5 average did not seem to overly influence these data with the possible exception that the growth of the turbulent mixing height was stunted.

During the period 1400-1600 there occurred an increase in sky opacity which was reflected in the turbulent mixing height after a short delay period. This is an outstanding example of the dependence of mixing height development upon sunshine or radiant energy input to the earth's surface.

FIGURE 4.
ATMOSPHERIC BEHAVIOR
ATLANTA, GEORGIA
SEPTEMBER 13, 1971



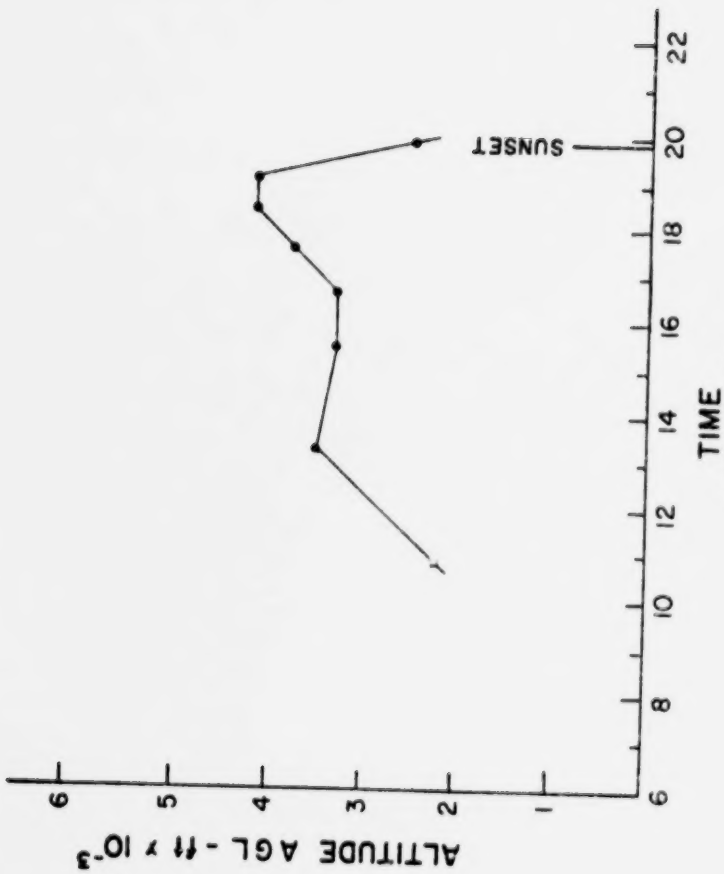


FIGURE 5.
TURBULENT MIXING HEIGHT
SEPTEMBER 13, 1971

WBAN-10C (2-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated First Stations)

To convert LST to GMT
ADD ____ hrs. SUBTRACT ____ hrs.

STATION: Atlanta, Ga. Fulton County Airport
DATE: September 13, 1971

TYPE	TIME (LST)	SKY AND CEILING (Hundreds of Feet)	VISIBILITY (Statute Miles) SURFACE	VISIBILITY (Statute Miles) TOWER	WEATHER AND OBSTRUCTIONS TO VISION	STA. PRESS (Tens and Units)	TEMP °F	DEW POINT °F	WIND DIR. (Tens of Degrees)	WIND SPEED (Knots)	WIND CHARACTER	ALTIM. SETTING (Hgs.)	REMARKS AND SUPPLEMENTAL CODED DATA	STATION PRESSURE (Hgs.)	SEA LEVEL PRESS. (Hgs.)	PRECIP. AMT. (Inches)	PRECIP. STA. TIME (Hours)	PRECIP. AMT. (Inches)	PRECIP. STA. TIME (Hours)
R	0052	O	7				64	57	30	07					64.1	55.5	0	0	
R	0155	O	7				63	55	30	05					62.3	53.1	0	0	
R	0255	O	7				62	55	25	05					62.0	53.0	0	0	
R	0355	O	7				61	56	27	04					61.9	57.6	0	0	
R	0455	O	7				61	55	30	05					60.6	57.0	0	0	
R	0552	O	6		GF		59	55	24	03					58.1	56.9	0	0	
R	0651	O	5		HK		59	54	21	05					59.0	56.1	0	0	
R	0752	O	5		HK		63	56	30	08					62.3	58.4	0	0	
RS	0853	E14 ⊕	4		HK		66	57	30	08					66.0	60.2	10	9	
S	0937	15 ⊙	5		HK		-	-	31	11					-	-	4	4	
R	0955	18 ⊙	6		HK		69	55	32	08					69.4	62.0	4	4	
R	1055	E 25 ⊙	7				72	57	34	10					71.9	64.4	6	5	
R	1155	35 ⊙	7				73	57	33	08					73.2	63.0	5	4	
R	1255	E 40 ⊙	7				74	53	33	10					74.0	64.0	8	7	
R	1356	20 ⊙	E 40 ⊙	7			75	58	36	10					74.9	64.2	7	6	
R	1454	E 45 ⊙	100 ⊙	7			76	56	33	12					76.0	63.3	8	7	
R	1555	45 ⊙		7			78	55	32	10					77.9	63.3	4	3	
R	1655	45 ⊙		7			75	54	32	09					74.8	61.7	4	3	
R	1757	O		7			70	59	32	06					70.9	62.8	Φ	Φ	
R	1854	O		7			72	56	31	03					71.8	62.0	Φ	Φ	
R	1956	O		7			68	59	24	03					68.2	62.1	0	0	
R	2055	O		6		K	66	58	33	02					65.9	61.2	0	0	
R	2155	O		7			64	59	27	04					63.8	60.5	0	0	
R	2255	O		7			62	59	00	00					62.0	58.3	0	0	
R	2355	O		7			60	57	02	03					60.0	58.4	0	0	

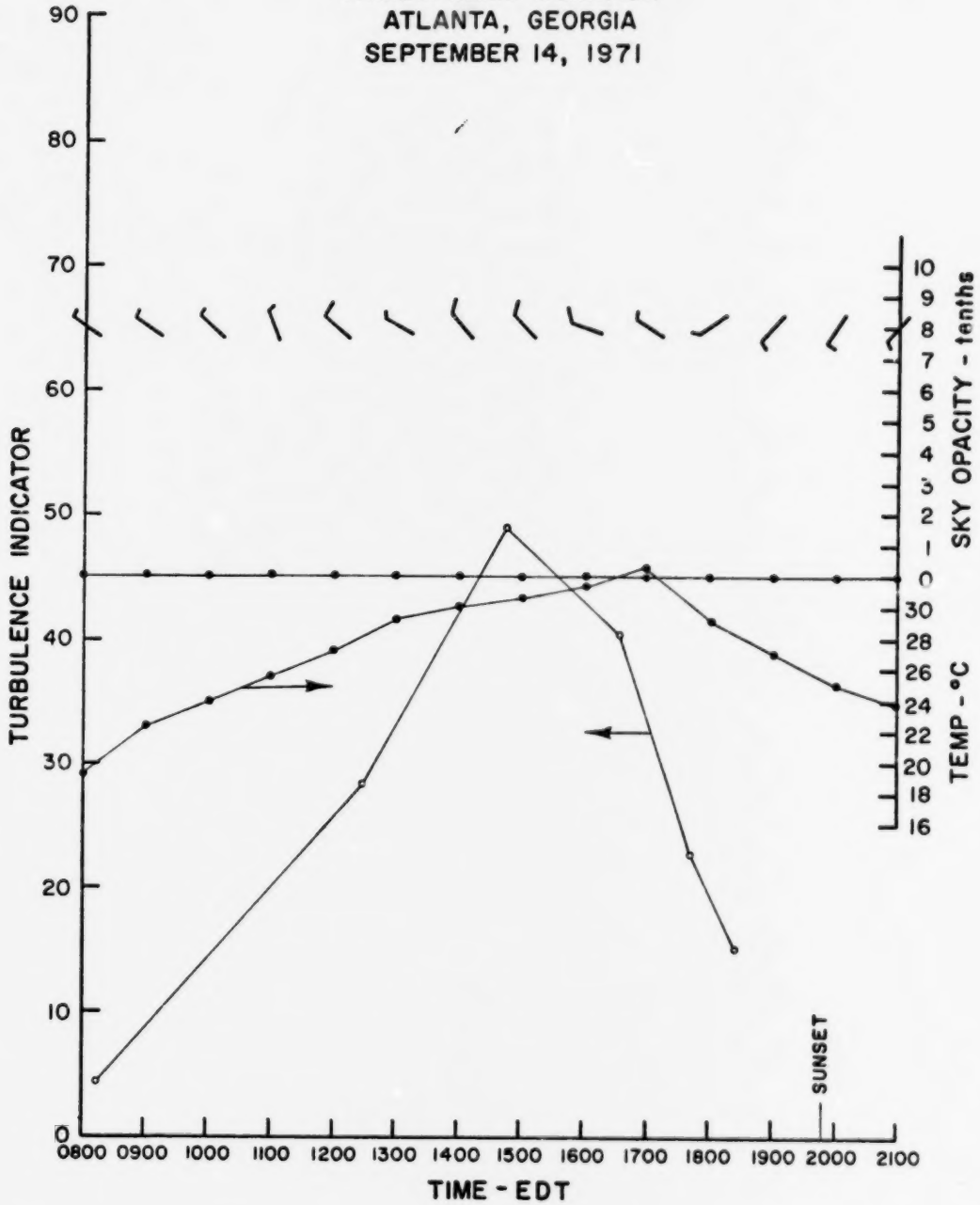
September 14, 1971

On September 14, 1971, a high pressure area was centered in southern Mississippi and the Atlanta area was still in the polar continental air mass which appeared the previous day. Winds aloft were northwesterly; about 25 to 30 knots at 18,000 feet. The air was comparatively dry and stable with dew points running in the fifties.

The high temperature for Atlanta this date was 90, and the low at 57. There was no precipitation recorded in the area during the 24-hour period.

This weather regime allowed another normal pattern of mixing height growth and decay.

FIGURE 6.
ATMOSPHERIC BEHAVIOR
ATLANTA, GEORGIA
SEPTEMBER 14, 1971



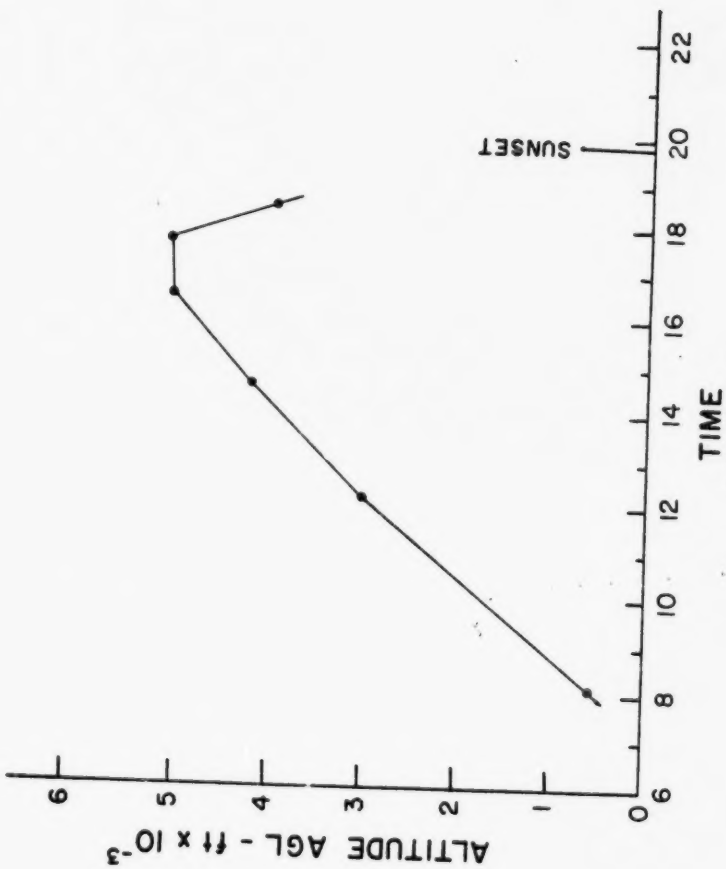


FIGURE 7.
TURBULENT MIXING HEIGHT
SEPTEMBER 14, 1971

MFI-10C
(8-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated Civil Stations)

To convert LST to GMT
ADD _____ hrs. SUBTRACT _____ hrs.

STATION: Atlanta, Ga. Fulton County Airport

DATE: September 14, 1971

TYPE	TIME (L.S.T.)	SKY AND CEILING (Hundreds of feet)	VISIBILITY (Statute miles) SURFACE	VISIBILITY (Statute miles) TOWER	WEATHER AND OBSTRUCTIONS TO VISION	SEA LEVEL PRESS (mb.)	TEMP. (°F)	DEW PT. (°F)	WIND DIRECTION (00-36)	WIND SPEED (Kts.)	WIND CHARACTER	ALTIM. SETTING (Ins.)	REMARKS AND SUPPLEMENTAL CODED DATA	STATION PRESSURE (Ins.)	DRY BULB (°F)	WET BULB (°F)	TOTAL SKY COVER	TOTAL OPAQUE SKY COVER	OBSERVERS INITIALS
(1)	(2)	(3)	(4)	(4a)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(17)	(18)	(19)	(21)	(30)	(31)
R	0058	O	7				58	56	00	00					58.0	56.8	O	O	
R	0158	O	7				58	56	00	00					58.0	56.0	O	O	
R	0256	O	5		GF		57	55	00	00					57.0	56.0	O	O	
R	0358	O	4		GF		57	55	00	00			VSBY LWR W		57.0	56.0	O	O	
R	0455	O	5		GF		58	55	00	00					58.0	56.0	O	O	
R	0555	O	5		H		60	54	34	03					59.9	56.8	O	O	
R	0657	O	7				60	55	06	03					60.2	57.4	O	O	
R	0755	O	7				67	53	29	06					66.9	61.1	O	O	
R	0855	O	7				72	58	30	07					71.5	63.1	O	O	
R	0955	O	7				75	60	31	07					75.2	65.0	O	O	
R	1056	O	8+				78	61	39	05					78.0	66.0	O	O	
R	1154	O	8+				81	60	30	09					81.0	67.0	O	O	
R	1253	O	8+				85	60	29	06					84.9	69.2	O	O	
R	1355	O	8+				86	61	30	10			F.E.W. CC		86.3	68.4	O	O	
R	1453	O	8+				87	61	30	10					87.3	69.5	O	O	
R	1555	O	8+				89	61	33	10					88.6	68.0	O	O	
R	1655	O	8+				90	61	29	07					89.6	67.0	O	O	
R	1751	O	8+				86	61	25	06					85.0	68.2	O	O	
R	1854	O	7				81	63	34	05					81.0	69.2	O	O	
R	1955	O	7				77	64	33	05					77.0	68.4	O	O	
R	2055	O	7				75	64	29	05					75.0	66.2	3	1	
R	2152	O	7				74	65	29	04					73.4	65.3	O	O	
R	2254	O	7				72	65	23	04					71.5	67.8	O	O	
R	2355	O	7				70	64	23	04					70.1	66.4	O	O	

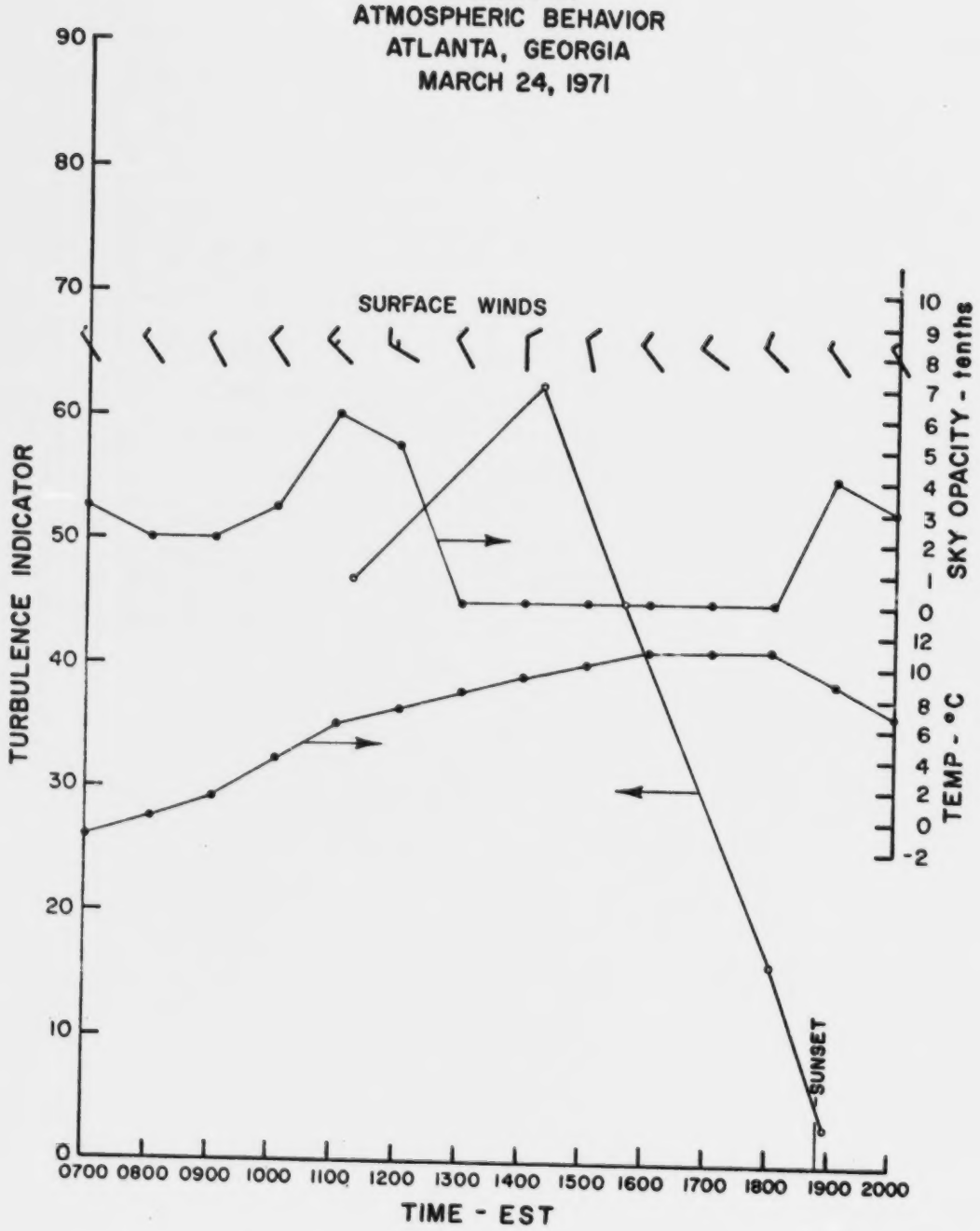
March 24, 1971

On March 24, 1971, the southeastern United States was dominated by a large mass of polar continental air centered over southern Minnesota. The upper wind flow was north-easterly on the surface backing to west-north-west up to 18,000 feet. The air was relatively dry and stable up to 18,000 feet and winds were fairly strong; upper winds at 18,000 feet were 80 knots. The high temperature during this period was 52 and the low 30. The area of precipitation barely skirts the Atlanta area and quite possibly some shower activity was experienced.

These data also provided what is considered an expected growth and decay pattern in turbulent mixing. The clearing sky in the morning hours contributed this pattern by allowing unrestricted solar heating.

There are several interesting observations for this date. Shortly after the noon hour the sky became clear thus allowing unobstructed radiant energy transfer. Surface temperatures continued to rise, peaking about 1700 hours, the mixing height somewhat followed the surface temperature pattern but the turbulence indicator displayed a decaying pattern from the 1400 hours. There is no readily apparent reason for this latter behavior.

FIGURE 8.
ATMOSPHERIC BEHAVIOR
ATLANTA, GEORGIA
MARCH 24, 1971



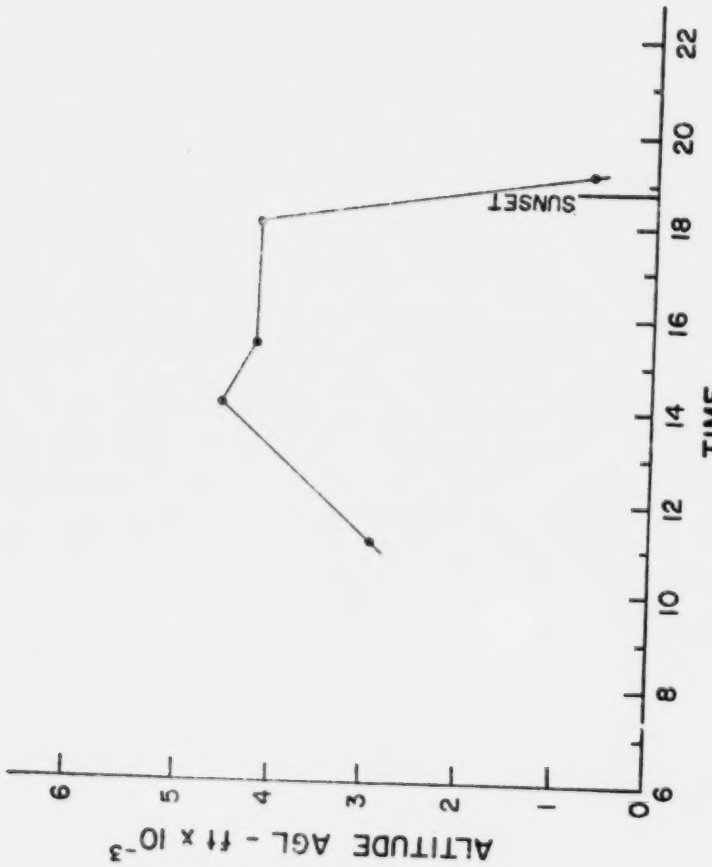


FIGURE 9
TURBULENT MIXING HEIGHT
MARCH 24, 1971

EPL-10C
10-71

To convert LST to GMT
ADD ____ hrs. SUBTRACT ____ hrs.

SURFACE WEATHER OBSERVATIONS
(Abridged for use at designated Civil Stations)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

STATION: At 2018, Ga. Fulton County Airport
DATE: March 24, 1971

TYPE	TIME (LST)	SKY AND CEILING (Hundreds of feet)	VISIBILITY (Statute miles) SURFACE	VISIBILITY TOWER	WEATHER AND OBSTRUCTIONS TO VISION	SEA LEVEL PRESS (mb)	TEMP (°F)	DEW PT (°F)	WIND DIRECTION (10's deg.)	WIND SPEED (kts)	WIND CHARACTER	ALTIM SETTING (Inches)	REMARKS AND SUPPLEMENTAL CODED DATA	STATION PRESSURE (Inches)	DRY BULB (°F)	WET BULB (°F)	TOTAL SKY COVER	PRIMARY SKY COVER	OBSERVATION TIME (GMT)
R	0056	E140 Ⓓ 250 Ⓓ	7				38	17	34	06					38.1	30.9	8	8	
R	0156	E140 Ⓓ 250 Ⓓ	7				36	11	34	08					36.4	30.0	6	6	
R	0255	E140 Ⓓ 250 Ⓓ	7				35	16	33	08					34.9	33.9	7	7	
R	0355	140 Ⓓ 250 Ⓓ	7				33	17	35	08					33.2	29.0	3	2	
R	0455	14 Ⓓ Ⓓ	7				32	17	34	10					31.9	27.5	2	2	
R	0556	250 - Ⓓ	7				31	18	33	06					31.2	29.0	3	1	
R	0654	250 - Ⓓ	7				30	22	33	06					30.1	27.2	8	3	
R	0755	250 - Ⓓ	7				32	19	32	05					32.4	28.0	8	2	
R	0855	250 - Ⓓ	7				35	20	34	07					35.2	30.1	8	2	
R	0955	250 - Ⓓ	7		~30 miles		39	19	33	09					39.1	32.0	9	3	
R	1055	E150 Ⓓ	7		in		43	12	30	14					43.0	32.5	8	6	
R	1155	E120 Ⓓ	7		aircraft		46	13	29	13					44.8	34.2	7	5	
R	1254	O	7				47	15	34	11			Few AC Cl		46.8	35.6	0	0	
R	1355	O	7				49	13	01	11			Few AC Cl		49.3	36.8	0	0	
R	1455	O	7				50	6	35	10			/FEW Cl		50.2	34.1	0	0	
R	1554	O	8+				53	11	33	08			/FEW Cl		52.4	35.4	0	0	
R	1655	O	8+				52	11	30	08			/FEW Cl		52.0	31.9	0	0	
R	1755	O	8+				52	9	31	08			/FEW Cl		51.7	31.3	0	0	
R	1855	250 Ⓓ	8+				48	10	32	06					47.8	35.4	4	4	
R	1955	250 Ⓓ	8+				45	16	33	05					44.5	34.5	3	3	
R	2054	250 Ⓓ	8+				42	X	00	00					42.0	33.5	5	3	
R	2153	E250 Ⓓ	8+				42	17	00	00					42.4	32.5	8	6	
R	2255	250 Ⓓ	9				40	19	00	00					40.2	32.8	7	3	
R	2351	250 Ⓓ	9				39	19	00	00					39.4	32.3	7	3	

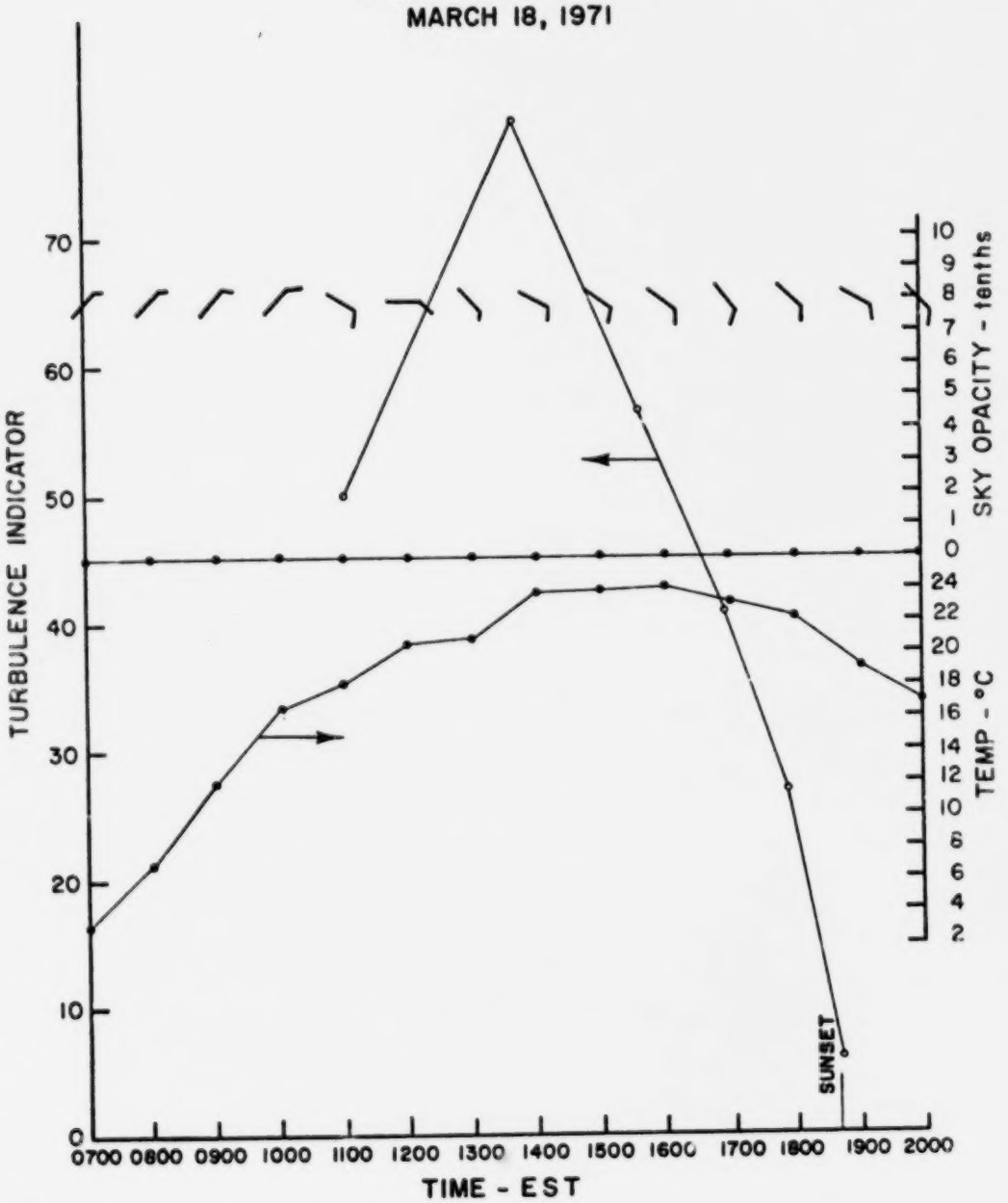
March 18, 1971

On March 18, 1971, a high pressure ridge extending from Pittsburg, Pennsylvania, to Columbia, South Carolina covered most of the eastern half of the nation. The lower level circulation over Gainesville was from the east. The winds at 18,000 feet were west-north-west at 30 to 40 knots. This was a polar continental air mass but with moisture coming in at lower levels due to the easterly winds. The temperature regime during the 24-hour period reached a high of approximately 76 and a low of 38. There was no precipitation for this 24-hour period.

This was a clear day with unusually large excursion in surface temperature. This resulted in high values of turbulence indicator with a very dramatic collapse in this indicator and turbulence mixing height near sunset.

Surface temperature and mixing height roughly peak at the same hour; some three hours after the turbulence indicator peak.

FIGURE 10.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
MARCH 18, 1971



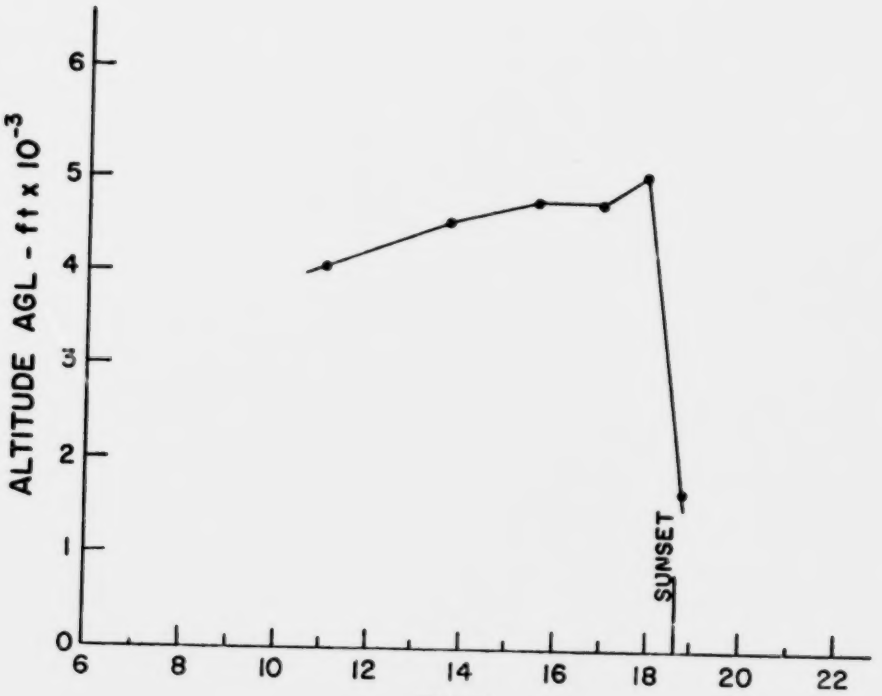
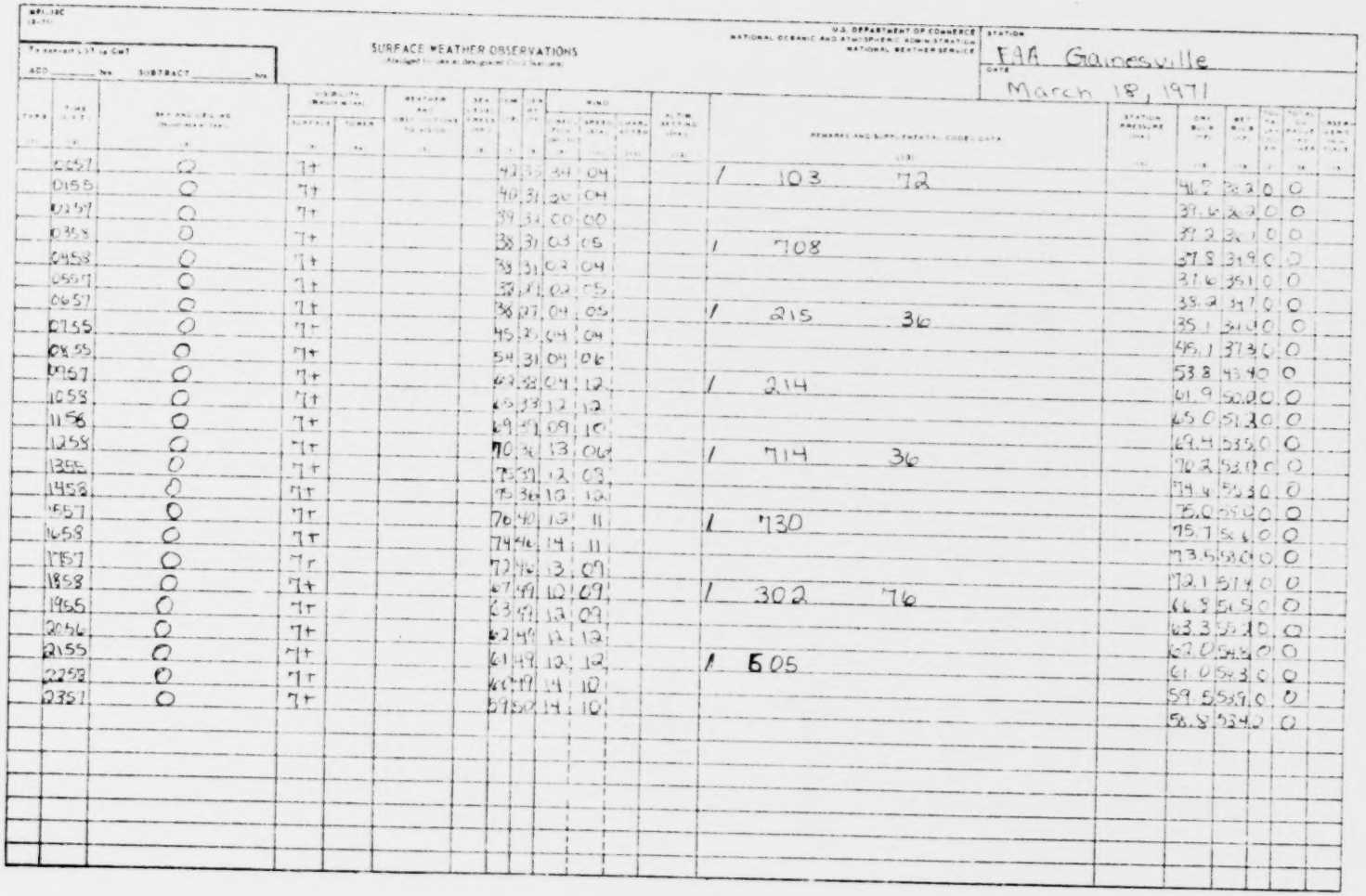


FIGURE 11.
TURBULENT MIXING HEIGHT
MARCH 18, 1971



SURFACE WEATHER OBSERVATIONS

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

STATION: EAA Gainesville

DATE: March 18, 1971

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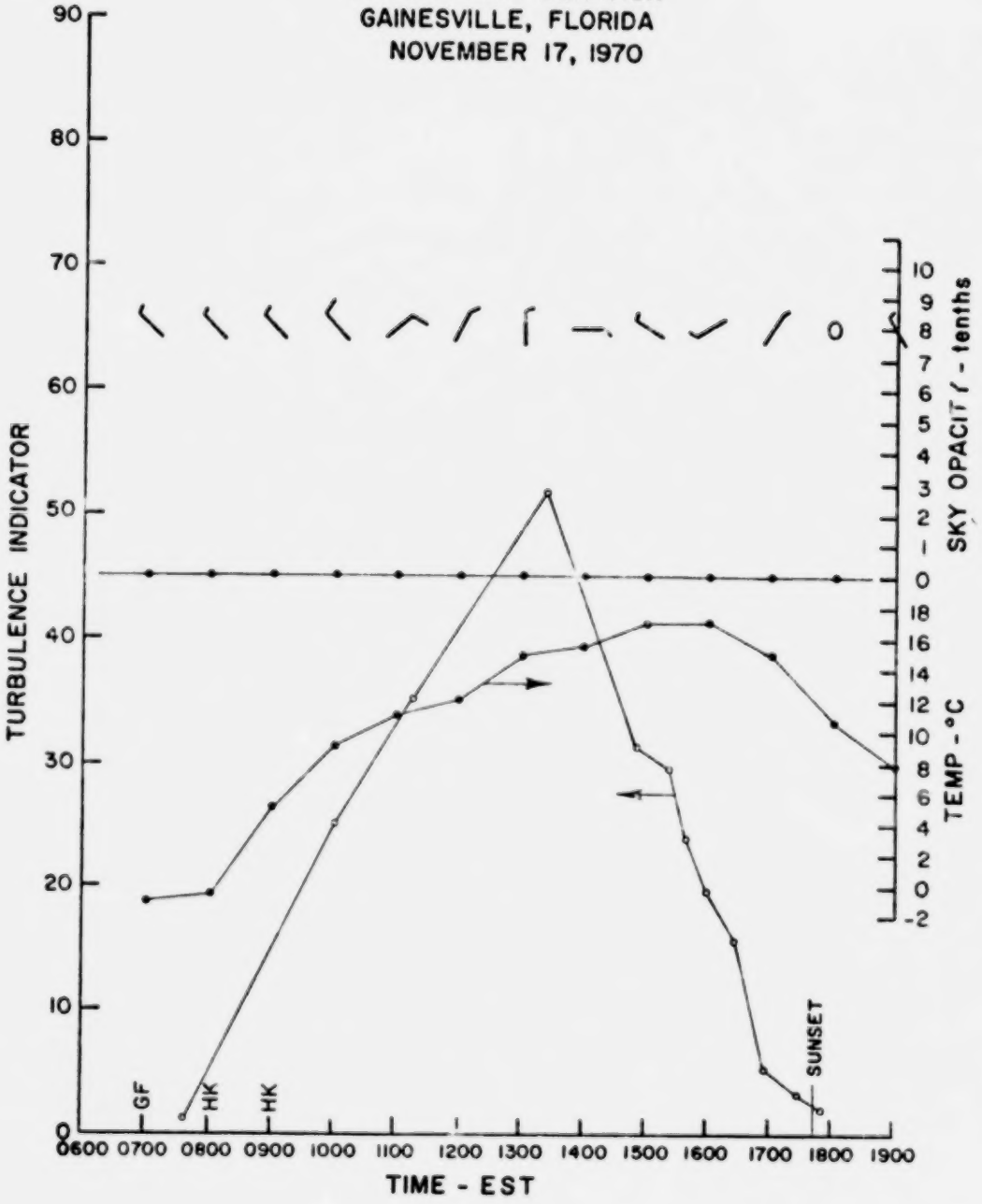
November 17, 1970

On November 17, 1970, a weak high pressure area covered the eastern half of the nation. The pressure gradient was weak and Gainesville surface circulation, which was westerly, was dominated by a high pressure center in the Gulf about 100 miles south of Pensacola. Winds aloft were generally westerly and at 18,000 feet were about 300°, at 20 knots. This was a polar continental air mass with relatively dry air. The Gainesville area experienced a high temperature in the neighborhood of 63 with lows in the high twenties. There was no precipitation during the 24-hour period.

This was a clear day with a large excursion in surface temperature. While values of turbulence indicator did not achieve levels of some other days, they were reasonably high and dissipated in the late afternoon exhibiting the dramatic collapse along with mixing height normally found in this time period. Surface winds were notably light but westerly.

Surface temperature and mixing height peak at the same hour; approximately three hours after the turbulence indicator peak.

FIGURE 12.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
NOVEMBER 17, 1970



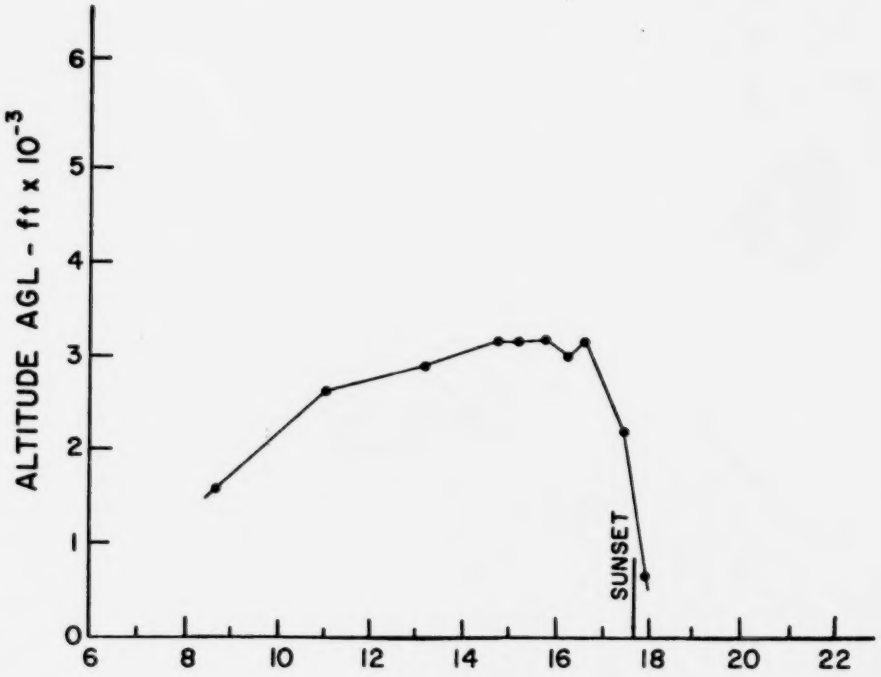


FIGURE 13.
TURBULENT MIXING HEIGHT
NOVEMBER 17, 1970

NPL-10C
(2-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

(Abridged from data at www.ncdc.noaa.gov/oa/ncdc.html)

To convert LST to GMT
ADD _____ hrs SUBTRACT _____ hrs

STATION: FAA - Gainesville, Fla.
DATE: November 17, 1970

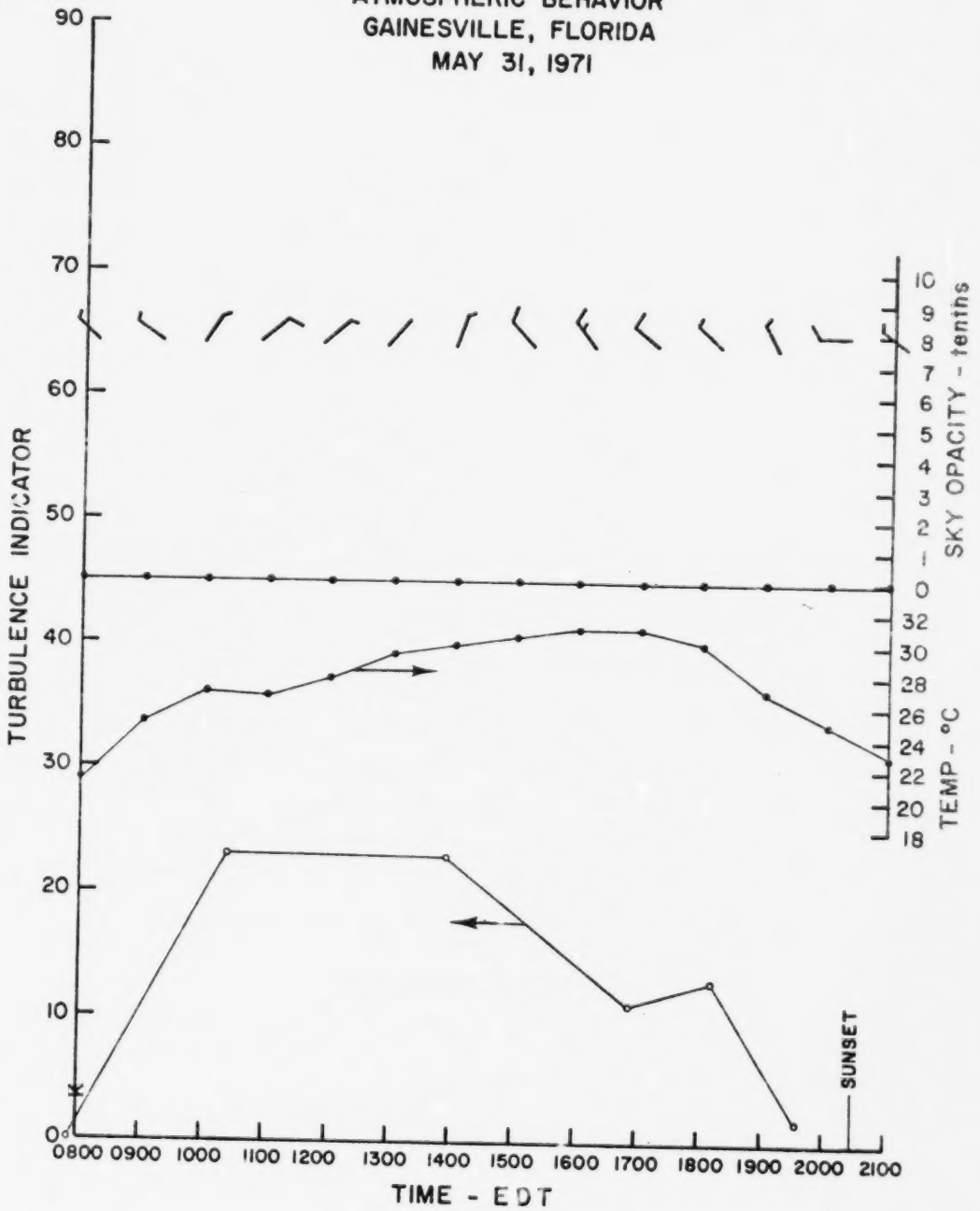
TYPE (1)	TIME (LST) (2)	SKY AND CEILING (Hundreds of Feet) (3)	VISIBILITY (Statute Miles) SURFACE (4)	VISIBILITY (Statute Miles) TOWER (5)	WEATHER AND OBSTRUCTIONS TO VISION (6)	SEA LEVEL PRESS (mb) (7)	TEMP °F (8)	DEW PT °F (9)	WIND DIR (Tens of Degrees) (10)	WIND SPEED (Kts.) (11)	WIND CHARACTER (12)	ALTIM. SETTING (Ins.) (13)	REMARKS AND SUPPLEMENTAL CODED DATA (14)	STATION PRESSURE (Ins.) (15)	DRY BULB (°F) (16)	WET BULB (°F) (17)	TOTAL SKY COVER (18)	TOTAL OPAQUE SKY COVER (19)	PRESENT WEATHER (Not Tabulated) (20)
R	0055	0	5		HK		31	30	00	00			/ 803 47		30.8	30.4	0	0	
R	0156	0	5		HK		31	30	24	04					30.8	30.0	0	0	
R	0256	0	7				29	28	33	05					29.0	28.4	0	0	
R	0355	0	7				29	27	32	05			/ 603		29.0	28.4	0	0	
R	0456	0	7				28	27	32	05					28.4	28.0	0	0	
R	0555	0	7				28	27	33	05					28.0	27.4	0	0	
R	0656	0	3		GF		29	27	32	05			/ 309 28		29.1	28.3	0	0	
R	0751	0	5		HK		31	31	32	05					31.0	30.2	0	0	
R	0856	0	6		HK		41	35	33	04					42.8	33.3	0	0	
R	0957	0	7				43	35	32	05			/ 210		43.0	33.8	0	0	
R	1056	0	7				52	36	06	08					51.9	44.3	0	0	
R	1157	0	7				54	32	03	05					54.0	45.3	0	0	
R	1258	0	7				58	32	36	05			/ 829 28		58.0	46.5	0	0	
R	1356	0	7				60	31	09	05					59.8	47.2	0	0	
R	1457	0	7				63	31	31	05					62.8	48.7	0	0	
R	1556	0	7				64	31	29	04			/ 614		62.9	50.4	0	0	
R	1657	0	7				57	31	02	05					58.4	49.0	0	0	
R	1756	0	7				54	46	00	00					54.0	50.3	0	0	
R	1856	0	7				46	39	31	04			/ 303 43		46.4	43.4	0	0	
R	1956	0	7				43	38	07	05					43.0	40.3	0	0	
R	2056	0	7				40	38	08	06					39.9	38.9	0	0	
R	2157	0	7				39	38	00	00			/ 470		38.9	37.1	0	0	
R	2256	0	6		H		38	38	00	00					38.4	37.5	0	0	
R	2357	0	4		H		38	38	31	04					38.4	37.8	0	0	

May 31, 1971

On May 31, 1971, a weak high pressure area dominated the southeastern part of the country. The center of the high was in northwestern Alabama. The wind flow at lower levels over Gainesville was north-westerly but very light. At approximately 18,000 feet, winds were north-westerly at 30 knots. The air was dry and stable. The temperature regime in Gainesville ranged from a high of 98 to a low 55 with no precipitation being experienced during the 24-hour period.

Surface temperature and mixing height follow typical pattern peaking at approximately 1700 hours. Turbulence indicator pattern is atypical in that growth stopped as early as 1000-1100 hours, and did not attain magnitudes that might be expected for a clear day. Explanation might be associated with light winds and higher than usual mixing heights attained, thus spreading the energy available to the higher altitudes.

FIGURE 14.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
MAY 31, 1971



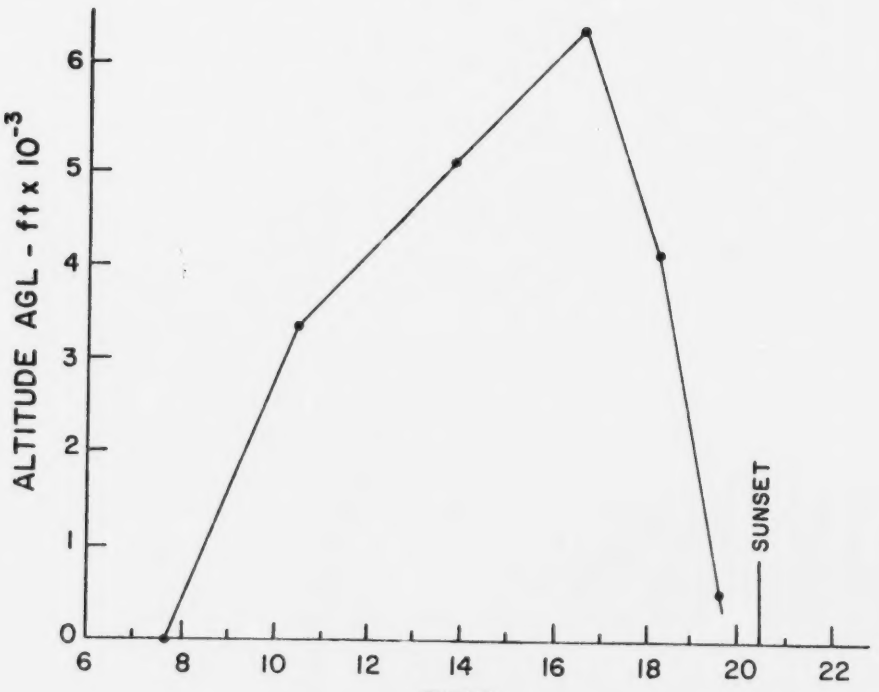


FIGURE 15.
TURBULENT MIXING HEIGHT
MAY 31, 1971

NPL-10C
(2-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated Civil Stations)

To convert LST to GMT
ADD _____ hrs SUBTRACT _____ hrs

STATION: FAA-Gainesville, Fla.

DATE: May 31, 1971

TYPE (1)	TIME (LST) (2)	SKY AND CEILING (hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (4)	VISIBILITY (Statute miles) TOWER (4a)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS (mb) (6)	TEMP (°F) (7)	DEW PT (°F) (8)	WIND DIRECTION (tens of degrees) (9)	WIND SPEED (Kts) (10)	WIND CHARACTER (11)	ALTIM SETTING (ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (ins.) (13)	DRY BULB (°F) (18)	WET BULB (°F) (19)	TOTAL SKY COVER (21)	TOTAL OPAQUE SKY COVER (21)	OBSERVERS INITIALS (23)
R	0058	0	7+				62	57	00	00			/ 703 84		62.2	59.0	0	0	
R	0156	0	7+				60	51	00	00					60.4	55.1	0	0	
R	0256	0	7+				57	56	00	00					58.8	55.0	0	0	
R	0358	0	7				58	56	00	00			/ 603		51.9	56.3	0	0	
R	0456	0	5		GFK		56	54	00	00					56.3	55.1	0	0	
S	0518	0	2		GFK		—		00	00					—	—	—	—	
R	0556	0	2		GFK		55	54	33	04					55.0	54.0	0	0	
S	0622	0	3		GFK		—		00	00					—	—	—	—	
R	0657	0	3		GFK		60	55	32	03			/ 217 55		59.9	55.9	0	0	
R	0756	0	4		K		71	55	32	04					71.6	63.0	0	0	
R	0857	0	7+				77	58	30	06					77.0	64.7	0	0	
R	0957	0	7+				80	55	03	04			/ 210		79.8	62.9	0	0	
R	1058	0	7+				80	52	06	08					79.8	62.9	0	0	
R	1156	0	7+				82	54	06	06					81.9	64.7	0	0	
R	1258	0	7+				85	58	20	05			/ 812 55		85.0	63.4	0	0	
R	1358	0	7+				84	54	01	09					82.1	62.6	0	0	
R	1455	0	7+				81	57	32	11					81.1	63.0	0	0	
R	1555	50-0	7+				83	59	33	14			/ 715		81.8	64.4	2	0	
R	1658	0	7+				83	56	30	10					83.3	63.8	0	0	
R	1755	0	7+				84	59	31	05					86.3	63.3	0	0	
R	1857	0	7+				81	59	35	03			303 88		81.1	64.9	0	0	
R	1958	0	7+				77	58	27	08					77.0	65.1	0	0	
R	2057	0	7+				74	58	30	05					73.9	64.0	0	0	
R	2158	0	7+				71	60	29	06			/ 117		71.2	64.9	0	0	
R	2256	0	7+				69	60	29	06					68.7	63.1	0	0	
R	2356	0	7+				68	61	30	05					67.9	63.4	0	0	

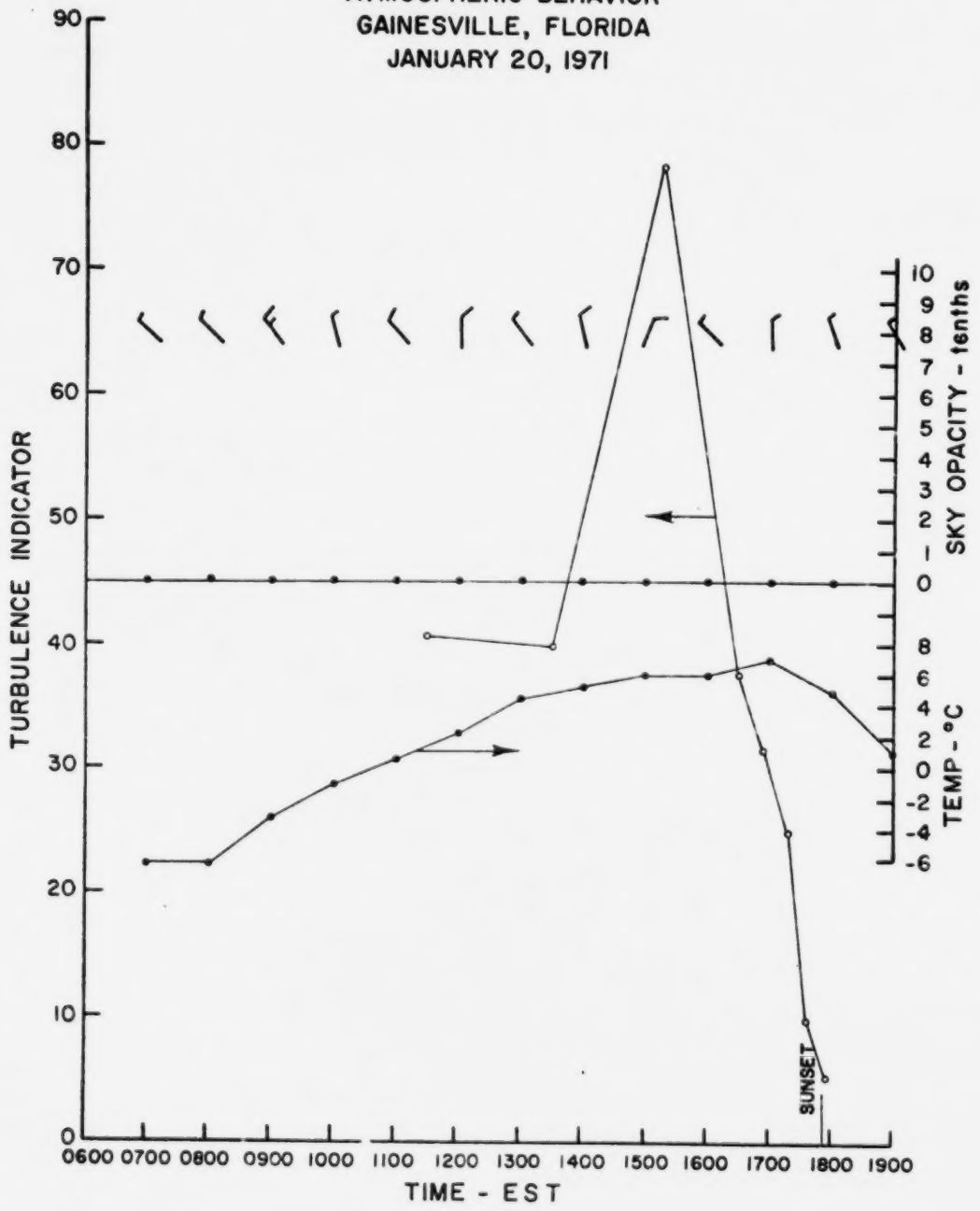
January 20, 1971

On January 20, 1971, the eastern half of the nation was dominated by a strong high pressure system centered over northwestern Alabama. Surface winds over Gainesville were north-westerly at 5 to 10 knots. However, winds in the upper atmosphere were rather strong; at 18,000 feet winds of over 80 knots were reported. The temperature during this 24-hour period ranged from a high of 45 to a low of 21. There was no precipitation during the period.

This was a clear day and the coldest experienced in the test program. Turbulence indicator values rose to high levels, dramatically decreasing with the approach of sunset. Turbulent mixing height followed an expected clear day pattern. Generally this would be considered a typical clear day.

Surface temperature and mixing height patterns correspond, each peaking at about 1700 hours. Turbulence indicator attained a high magnitude and peaked approximately two hours earlier at 1500 hours.

FIGURE 16.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
JANUARY 20, 1971



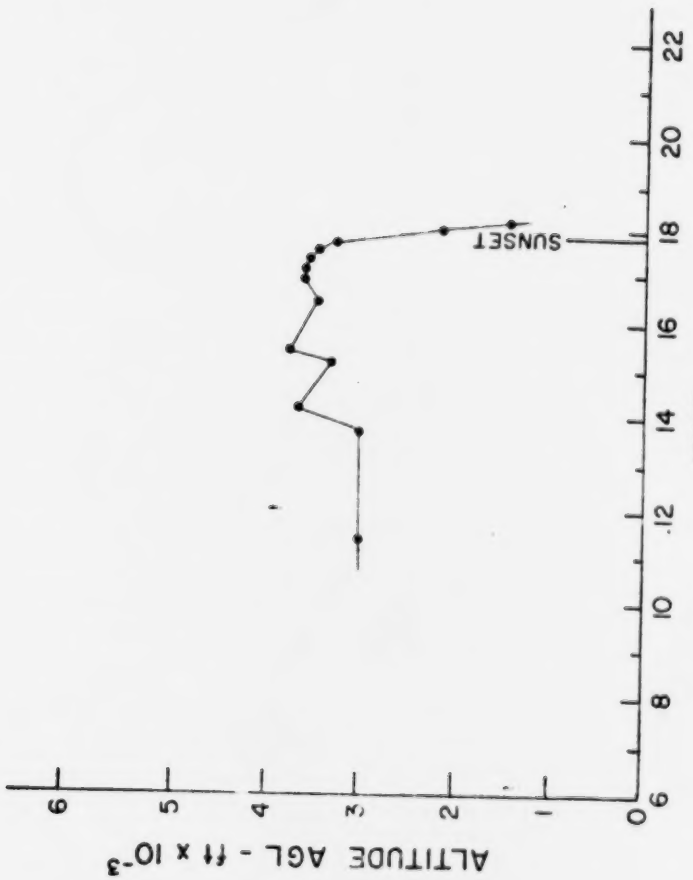


FIGURE 17.
TURBULENT MIXING HEIGHT
JANUARY 20, 1971

WBAN-10C (2-71)

SURFACE WEATHER OBSERVATIONS

(Assigned for use at designated Civil Stations)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

To convert LST to GMT
ADD ____ hrs SUBTRACT ____ hrs

STATION: FAA Gainesville, Fla.

DATE: January 20, 1971

TYPE	TIME (LST)	SKY AND CEILING (Hundreds of feet)	VISIBILITY (Statute miles) SURFACE	VISIBILITY (Statute miles) TOWER	WEATHER AND OBSTRUCTIONS TO VISION	SEA LEVEL PRESS (mb)	TEMP (°F)	DEW PT (°F)	WIND DIRECTION (tens of deg)	WIND SPEED (kts)	WIND CHARACTER	ALTIM SETTING (Hg)	REMARKS AND SUPPLEMENTAL CODED DATA	STATION PRESSURE (Hg)	DRY BULB (°F)	WET BULB (°F)	TOTAL SKY COVER	TOTAL OPAQUE SKY COVER	REMARKS IN PLAIN TALK
R	0055	0	7				28	13	33	05			/ 217 5 8		28.2	24.3	0	0	
R	0155	0	7				27	15	33	05					26.8	23.6	0	0	
R	0255	0	7				26	13	34	07					25.6	22.2	0	0	
R	0355	0	7				25	11	33	05			/ 217		24.6	21.4	0	0	
R	0455	0	7				23	16	32	05					23.2	21.2	0	0	
R	0555	0	7				22	12	32	05					22.0	19.3	0	0	
R	0655	0	7				21	11	32	06			/ 220 21		21.2	19.0	0	0	
R	0756	0	7				21	11	32	05					21.1	18.9	0	0	
R	0857	0	7				24	13	33	13					24.0	22.6	0	0	
R	0957	0	7				30	15	35	07			/ 327		29.9	25.7	0	0	
R	1058	0	7				33	14	32	10					33.4	28.0	0	0	
R	1157	0	7				36	18	36	08					35.7	29.4	0	0	
R	1257	0	7				40	17	33	06			/ 817 21		39.5	31.9	0	0	
R	1355	0	7				42	13	35	10					41.9	32.7	0	0	
R	1456	0	7				43	09	01	08					43.0	32.6	0	0	
R	1556	0	7				43	11	30	06			/ 610		43.0	33.0	0	0	
R	1656	0	7				45	11	35	05					44.8	34.0	0	0	
R	1755	0	7				41	15	35	05					41.0	32.4	0	0	
R	1858	0	7				34	20	34	05			/ 212 45		33.5	28.0	0	0	
R	1956	0	7				30	X	00	00					30.0	27.0	0	0	
R	2055	0	7				28	18	30	04					27.0	25.1	0	0	
R	2156	0	7				28	19	00	00			/ 215		29.0	26.0	0	0	
R	2257	0	7				25	18	00	00					25.2	23.3	0	0	
R	2356	0	7				24	21	00	00					24.0	22.9	0	0	

January 21, 1971

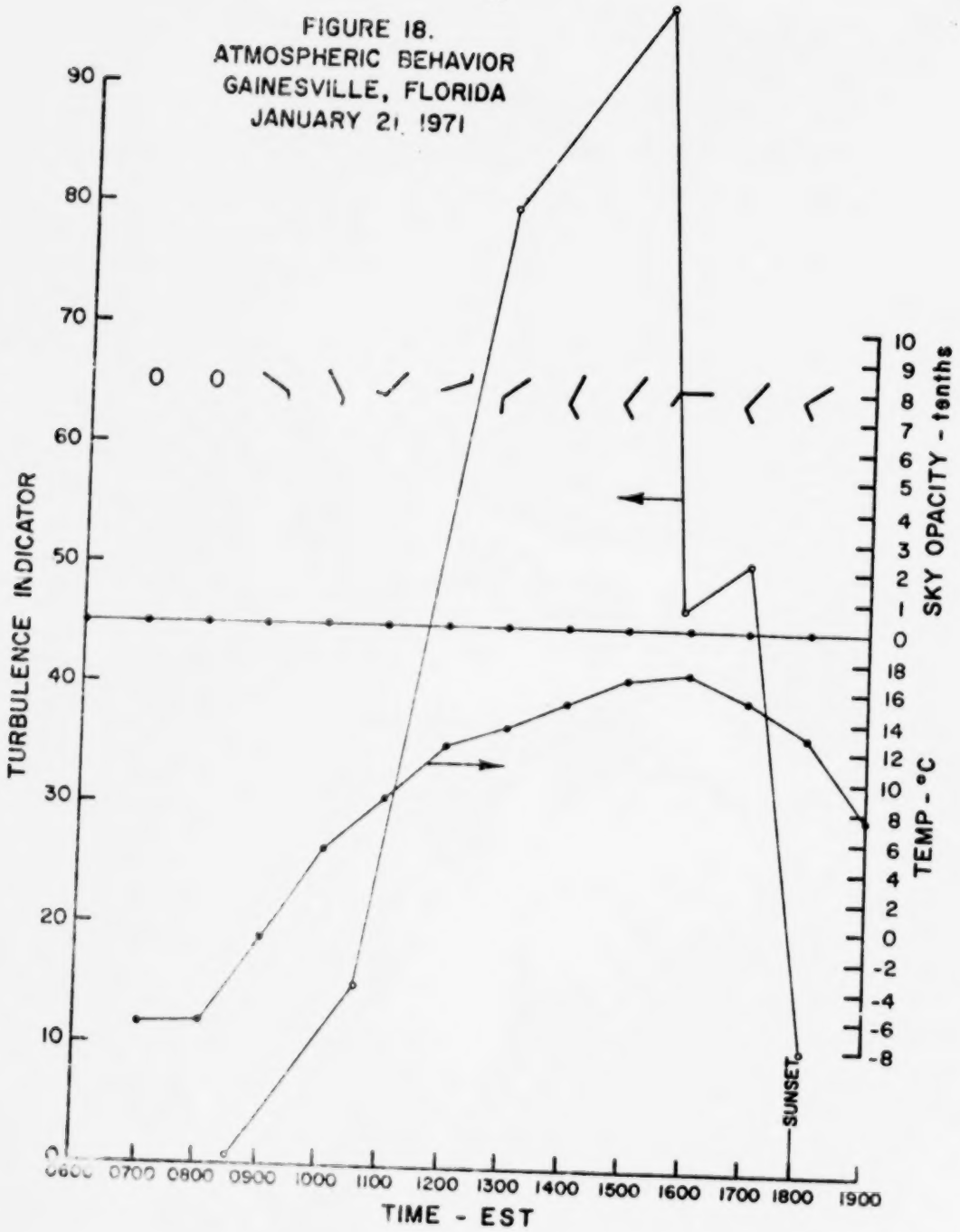
On January 21, 1971, the southeastern United States was under the domination of a continuing high pressure system centered over north central Florida. The winds at Gainesville were near calm in the morning due to the weakness of the pressure gradient near the center of the high. As the high drifted eastward off the coast of Florida during the afternoon, winds shifted to southwest bringing in some low level warm moist air. This moisture layer was very shallow and no precipitation occurred. The winds at 18,000 feet were backed around from northwesterly on the previous date to west-north-west on the 21st. They averaged about 30 knots. The temperature regime during the 24-hour period ranged from a high of 63 to a low of 20.

With clear skies all day, this date experienced an unusually high temperature excursion from sunup until the high for the day; some 43 fahrenheit degrees. Winds were light and variable in direction. The turbulence indicator rose to the highest values experienced in these series of experiments. The turbulent mixing height pattern was typical for clear weather.

Surface temperature and mixing height both peaked at approximately 1600 hours. Turbulence indicator attained quite high magnitudes. The combination of high turbulence indicator, reasonably high mixing height and a quite high surface temperature excursion, would seem to suggest an influence of the warm moist air. The afternoon entry of this air would suggest super adiabatic lapse rates. Dew point data

recorded by the Gainesville FAA station show the entry of this moist air. Sufficient data are not available to confirm the super-diabatic condition.

FIGURE 18.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
JANUARY 21, 1971



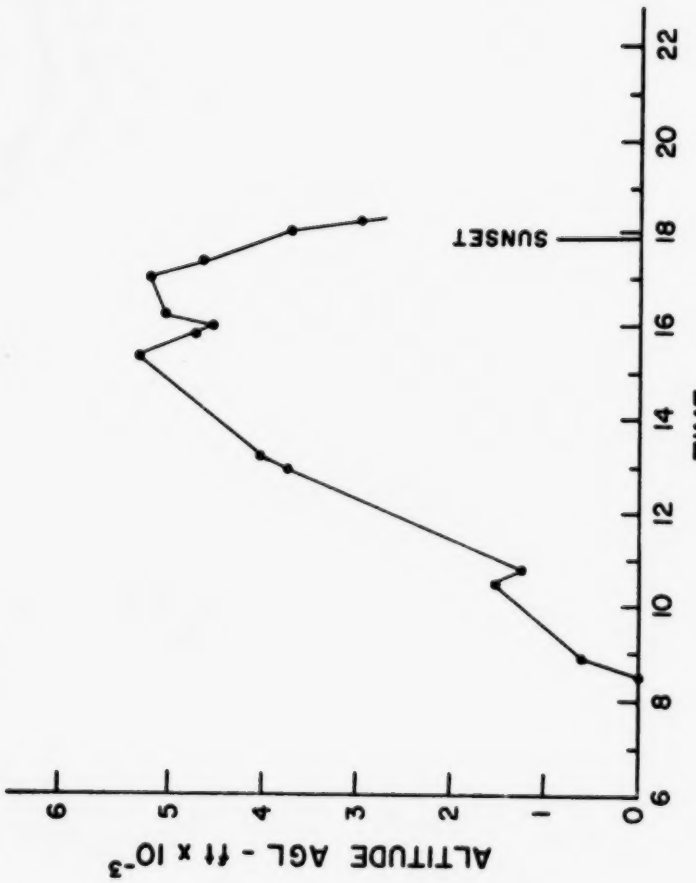


FIGURE 19.
TURBULENT MIXING HEIGHT
JANUARY 21, 1971

To convert LST to GMT
ADD ____ hrs SUBTRACT ____ hrs

SURFACE WEATHER OBSERVATIONS

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

STATION: FAA Gainesville, Fla.
DATE: January 21, 1971

TYPE	TIME (LST)	SKY AND CEILING (Hundreds of feet)	VISIBILITY (Statute miles) SURFACE	VISIBILITY (Statute miles) TOWER	WEATHER AND OBSTRUCTIONS TO VISION	SEA LEVEL PRESS (mb)	TEMP	DEW PT	WIND DIRECTION	WIND SPEED (Kts)	WIND CHARACTER	ALTIM SETTING (inHg)	REMARKS AND SUPPLEMENTAL CODED DATA	STATION PRESSURE (inHg)	DRY BULB (°F)	WET BULB (°F)	TOTAL SKY COVER	TOTAL OPAQUE SKY COVER	WIND (24 HR) RUN (MILES)
R	0055	0	7				23	19	00	00			/ 603 415		23.0	21.5	0	0	
R	0158	0	7				22	18	30	04					22.1	20.3	0	0	
R	0255	0	7				21	18	34	04					21.0	20.0	0	0	
R	0358	0	7				20	18	00	00			/ 807		20.1	18.2	0	0	
R	0457	0	7				20	18	30	04					20.3	18.7	0	0	
R	0555	0	7				19	18	00	00					20.1	18.7	0	0	
R	0658	0	7				20	16	00	00					20.0	18.3	0	0	
R	0755	0	5		K		20	17	00	00			/ 503 20		20.0	19.6	0	0	
R	0856	0	5		K		20	24	11	05					21.8	22.1	0	0	
R	0956	0	7				31	20	36	07			/ 307		41.4	33.4	0	0	
R	1056	0	7				47	18	24	04					46.8	34.4	0	0	
R	1153	0	7				54	16	28	04					53.1	40.4	0	0	
R	1258	0	3		K		56	30	24	09			/ 817 20		56.0	41.2	0	0	
R	1356	0	7				59	28	31	10					59.2	44.0	0	0	
R	1457	0	7				62	24	21	10					61.5	45.7	0	0	
R	1556	0	7				63	23	27	11			/ 824		62.8	45.9	0	0	
R	1657	0	7				60	23	24	10					60.1	43.4	0	0	
R	1755	0	7				58	23	24	10					55.0	41.3	0	0	
R	1857	0	7				46	24	00	00			/ 000 63		46.0	39.0	0	0	
R	1956	0	7				43	23	00	00					39.9	35.1	0	0	
R	2058	0	7				38	23	00	00					38.0	32.4	0	0	
R	2157	0	7				35	26	00	00			/ 400		35.2	32.0	0	0	
R	2256	0	7				34	27	00	00					33.9	31.5	0	0	
R	2357	0	7				34	27	00	00					33.8	32.0	0	0	

May 7, 1971

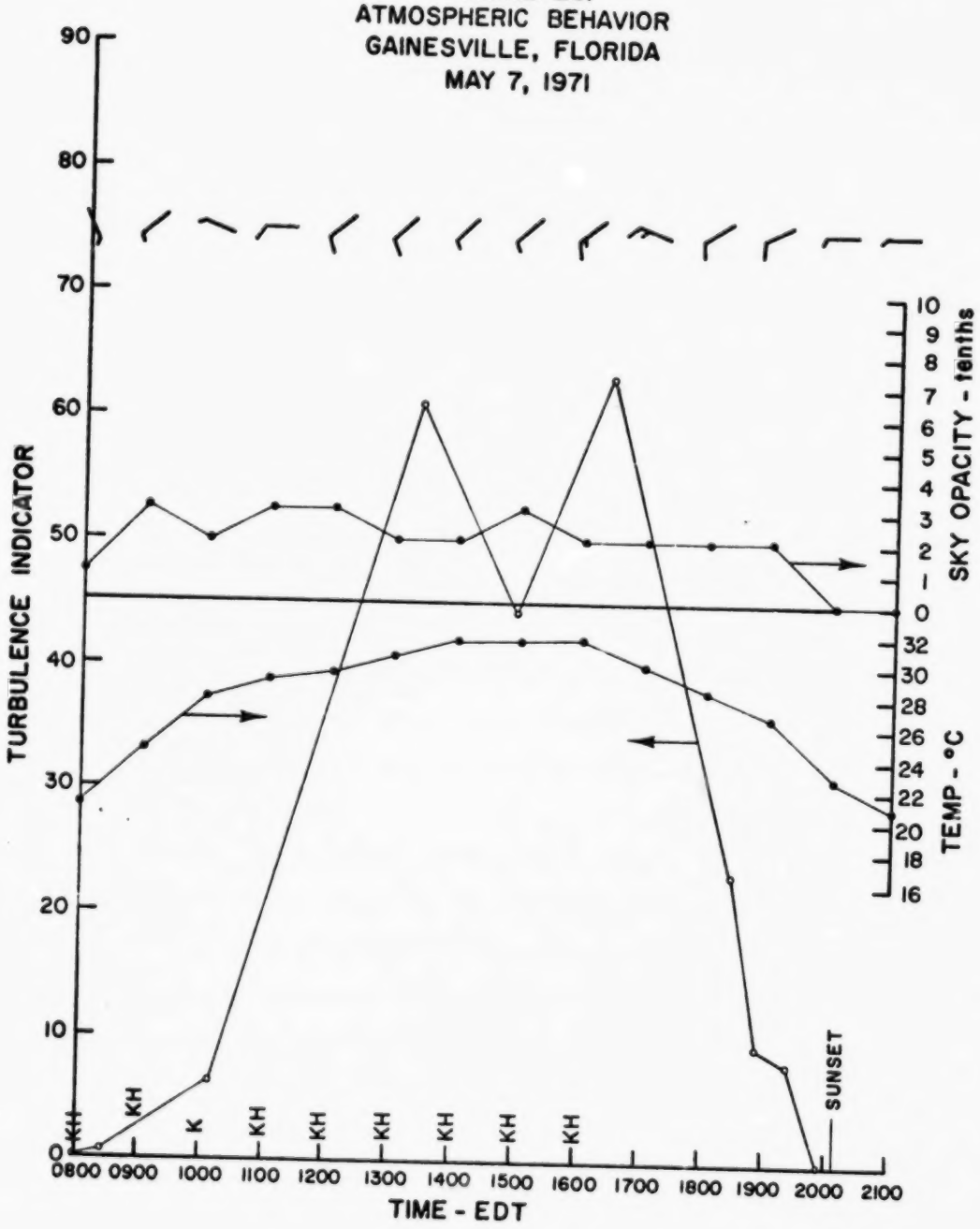
On the 6th of May, the Bermuda high was centered about 300 miles east of Melbourne, Florida. The pressure gradient indicated that winds would be south-westerly during the day. On the 7th, the same pressure system dominated the area. However, the high had drifted further out to sea and the pressure gradient weakened considerably. Some low level moisture was coming in. The winds were very light and variable at times at the surface. Winds aloft (18,000 feet) were west-south-west at 20 knots. Dew points on the morning of the 7th were in the fifties. Surface temperatures cooled to very near the dew point during the night so that on the morning of the 7th, there was patchy ground fog all over north Florida. This, however, dissipated quickly after sunrise due to the dryness of the air aloft.

The temperature regime for this date ranged from a high of 89 to a low of 59. There was no precipitation reported in the Florida area.

This was a day with partial but continuous sky opacity. The turbulence indicator pattern has an unexplained dip at the time period that its maximum value might have been expected. Turbulent mixing height displayed a typical pattern with possibly a slower collapse rate than observed on some clear days.

Surface temperature and mixing height followed similar patterns, both peaking about 1600 hours. Turbulence indicator also peaked at this approximate time. The several peaks are not as well defined as those occurring on some of the days with no cloud cover.

FIGURE 20.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
MAY 7, 1971



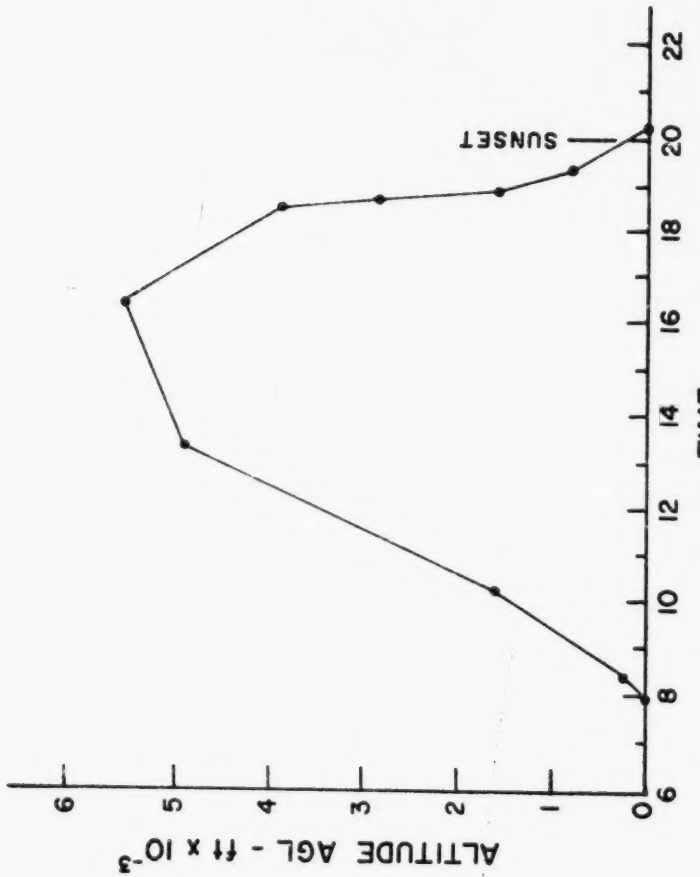


FIGURE 21.
TURBULENT MIXING HEIGHT
MAY 7, 1971

NPL-10C
(2-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated Civil Stations)

STATION: FAA Gainesville, Fla.

DATE: May 7, 1971

To convert LST to GMT
ADD ____ hrs SUBTRACT ____ hrs

TYPE (1)	TIME (L.S.T.) (2)	SKY AND CEILING (hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (4)	VISIBILITY (Statute miles) TOWER (4a)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS (mb.) (6)	TEMP (°F) (7)	DEW PT (°F) (8)	WIND DIRECTION (tens of degrees) (9)	WIND SPEED (kts.) (10)	WIND CHARACTER (11)	ALTIM. SETTING (Ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (Ins.) (14)	DRY BULB (°F.) (15)	WET BULB (°F.) (16)	TOTAL SKY COVER (17)	TOTAL OPAQUE SKY COVER (18)	OBSERVER'S INITIALS (19)
R	0058	0	6		K		62	59	00	00			/ 102 88		62.3	60.2	0	0	
R	0156	0	5		K		61	58	35	04					60.9	59.3	0	0	
R	0251	0	5		K		61	58	00	00					60.6	59.0	0	0	
R	0356	0	4		GFK		60	58	00	00			/ 710		60.1	58.7	0	0	
R	0453	0	4		GFK		59	57	00	00					59.3	58.1	0	0	
R	0558	100 Φ	3		GFK		60	58	00	00					59.3	57.6	1	1	
R	0657	130-Φ	4		GFK		63	58	00	00			/ 500 57		62.3	59.7	3	0	
R	0758	200-Φ	4		KH		70	61	16	05					67.7	61.5	5	1	
R	0856	200-ΦΦ	6		KH		76	64	35	06					75.8	69.1	9	3	
R	0953	200 Φ	5		K		82	67	28	01			/ 120		81.0	71.8	8	2	
R	1058	200-Φ	5		KH		84	69	27	11					83.6	69.8	7	3	
R	1153	200-ΦΦ	5		KH		85	69	23	10					85.2	70.9	9	3	
R	1253	200-ΦΦ	5		KH		87	69	23	08			/ 014 57		87.0	72.6	8	2	
R	1358	200-ΦΦ	5		KH		89	69	23	06					89.0	72.9	7	2	
R	1456	250-ΦΦ	5		KH		89	67	24	04					88.8	70.8	8	3	
R	1555	350-Φ	5		KH		89	66	24	15			/ 724		89.0	69.8	5	2	
R	1656	300 Φ	7+				86	63	28	13					86.0	67.7	3	2	
R	1758	300 Φ	7+				83	59	25	12					83.0	67.3	3	2	
R	1856	300 Φ	7+				80	61	26	10			/ 207 90		79.8	66.5	3	2	
R	1955	O	7+				75	57	27	07					73.3	63.2	0	0	
R	2055	O	7+				70	56	27	06					70.1	61.6	0	0	
R	2155	C	7+				68	56	27	05			/ 714		67.5	60.5	0	0	
R	2256	O	7+				64	51	29	04					64.2	57.2	0	0	
R	2356	O	7+				63	57	02	00					63.0	56.4	0	0	

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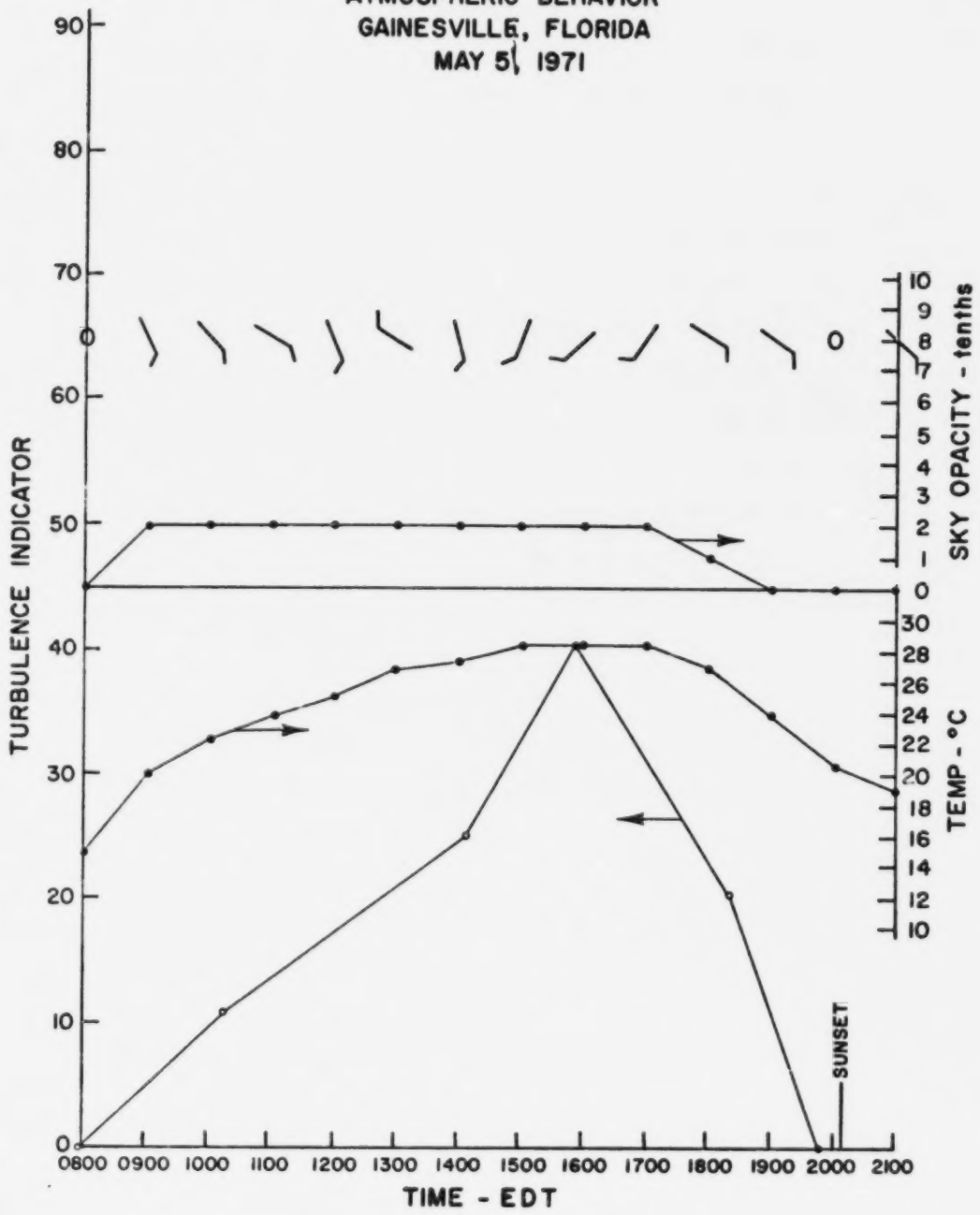
May 5, 1971

On May 5, 1971 an eastwardly drifting high pressure center was located about 300 miles east of Daytona Beach. The Gainesville area had near calm in the morning but by afternoon winds became light south-easterly. Some low level moisture existed due to the winds off the adjacent sea. The winds at 18,000 feet were about 320° at 20 knots. This was a dry and stable air mass. The temperature regime during the 24-hour period ranged from a high of approximately 83 to a low of 47. There was no precipitation reported during this period.

This was a day with continuous but partial sky opacity. Surface winds were light and variable. Other parameters exhibit what might be considered expected behavior with respect to buildup and collapse of the mixing layer.

Surface temperature and mixing height followed similar patterns, both peaking at about 1600 hours. Turbulence indicator also peaked at this approximate time. The several peaks are not as well defined as those occurring on some of the days with no cloud cover.

FIGURE 22.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
MAY 5, 1971



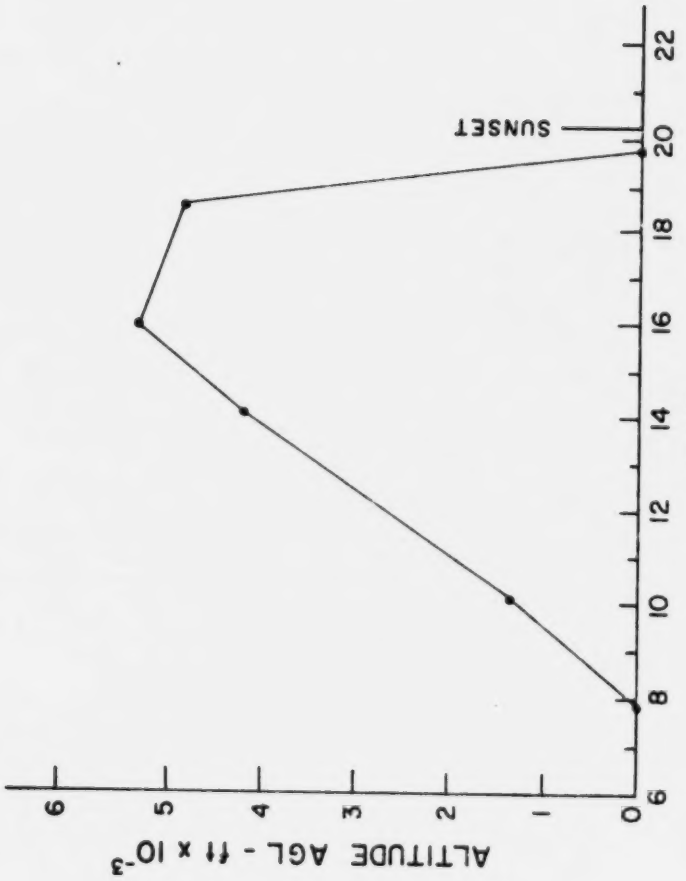


FIGURE 23.
TURBULENT MIXING HEIGHT
MAY 5, 1971

NP1-10C
(2-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated Coastal Stations)

To convert LST to GMT
ADD _____ hrs. SUBTRACT _____ hrs.

STATION: FAA Gainesville, Fla.
DATE: May 5, 1971

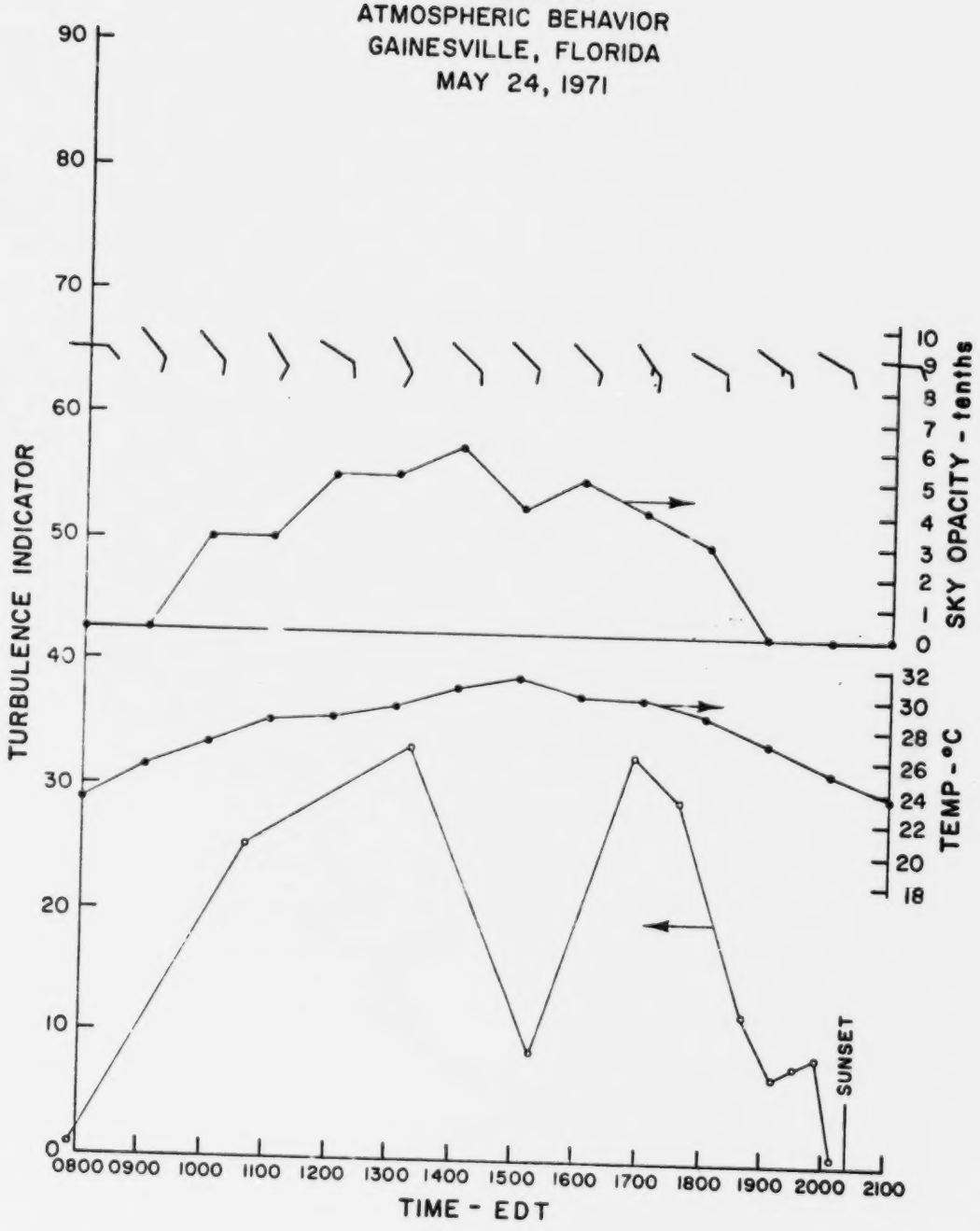
TYPE (1)	TIME (L.S.T.) (2)	SKY AND CEILING (Hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (4)	VISIBILITY (Statute miles) TOWER (4a)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS (mb.) (6)	TEMP (°F) (7)	DEW PT. (°F) (8)	WIND DIRECTION (00 = 360) (9)	WIND SPEED (Kts.) (10)	WIND CHARACTER (11)	ALTIM. SETTING (Ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (Ins.) (13)	DRY BULB (°F) (14)	WET BULB (°F) (15)	TOTAL SKY COVER (16)	TOTAL OPAQUE SKY COVER (17)	OBSERVER'S INITIALS (18)
R	0038	0	7+				51	46	00	00			/805 76		50.6	47.6	0	0	
R	0151	0	7+				50	45	00	00					50.4	47.5	0	0	
R	0236	0	7+				50	45	00	00					49.9	47.5	0	0	
R	0358	0	7+				49	46	00	00			/303		49.4	47.5	0	0	
R	0458	0	7+				47	44	00	00					47.0	46.7	0	0	
R	0551	0	7				47	44	00	00					46.7	45.3	0	0	
R	0658	0	7				50	45	00	00			/215 46		50.2	47.6	0	0	
R	0758	0	7				53	49	00	00					53.3	53.0	0	0	
R	0858	250 ⊕	7+				63	51	16	05					67.6	57.5	2	2	
R	0958	250 ⊕	7+				72	49	14	12			/002		71.6	55.6	2	0	
R	1058	250 ⊕	7+				75	50	12	08					75.0	60.3	3	2	
R	1156	300 ⊕	7+				77	52	16	07					77.3	61.9	5	2	
R	1258	300 ⊕	7+				80	53	28	10			/815 46		80.0	63.6	2		
R	1358	300 ⊕	7+				81	49	17	04					80.5	62.5	2		
R	1457	300 ⊕	7+				82	52	19	10					82.1	63.5	2		
R	1556	300 ⊕	7+				83	54	23	06			/715		83.0	65.3	7	2	
R	1658	300 ⊕	7+				83	50	23	06					83.0	63.5	5	2	
R	1756	300 ⊕	7				81	51	12	08					80.9	64.1	3	1	
R	1853	0	7				75	55	12	05			/500 83		75.0	62.8	0	0	
R	1956	0	7				69	56	00	00					68.8	60.6	0	0	
R	2057	0	7				67	53	15	07					67.0	59.0	0	0	
R	2158	0	7				66	57	13	05			/219		64.9	59.5	0	0	
R	2251	0	7				64	55	12	05					63.6	58.6	0	0	
R	2356	0	7				64	55	14	07					64.0	58.6	0	0	

May 24, 1971

On May 24, 1971, there was a high pressure centered 300 miles east of Wilmington, North Carolina. The high pressure extended all the way up Hudson Bay. There was an intense low pressure system over the western great lakes with a trough extending to southern Texas. This deepening low pressure system and trough in combination with the high produced a strong pressure gradient. Surface winds for the day were generally southeast to southerly. The winds at 18,000 feet were about 340°, at 15 knots. The temperature in Gainesville ranged from approximately a high of 88 to a low of 60. There was no precipitation report for Gainesville during the 24-hour period.

An interesting day in that the sky opacity increased during the morning thereafter decreasing in the afternoon, becoming clear again before sunset. Some anomaly occurred at approximately 1500 hr. as reflected in a sharp decrease in turbulence indicator and turbulent mixing height. No data available seem to explain this behavior. The possibility exists that a local rainshower occurred and did not get recorded on the weather observation sheet. The rapid collapse prior to sunset is still evident, having occurred some time after the above anomaly.

FIGURE 24.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
MAY 24, 1971



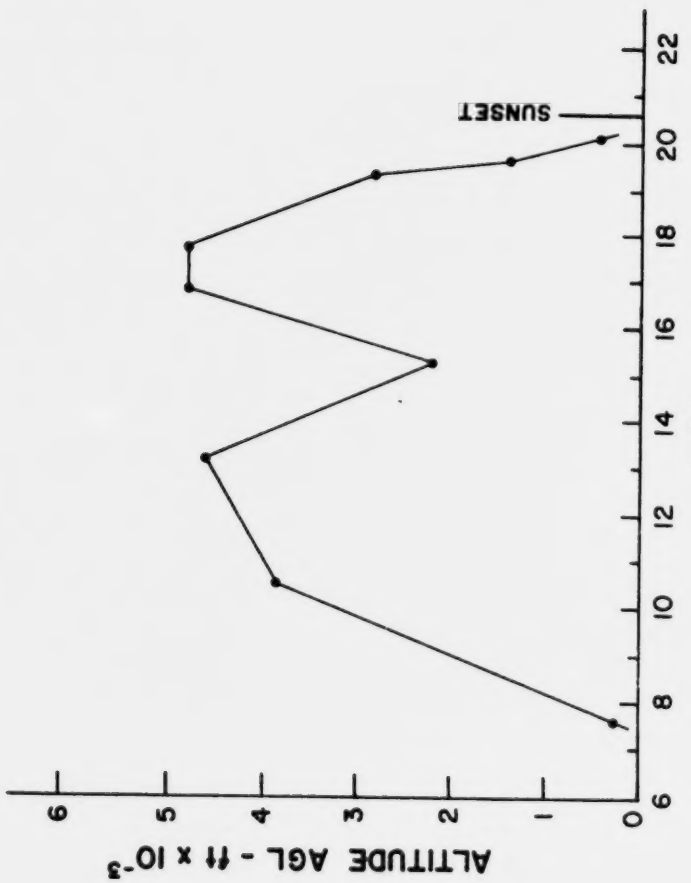


FIGURE 25.
TURBULENT MIXING HEIGHT
MAY 24, 1971

To convert LST to GMT: ADD ____ hrs. SUBTRACT ____ hr.

SURFACE WEATHER OBSERVATIONS

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

STATION: FAA - Gainesville, Fla.

DATE: May 24, 1971

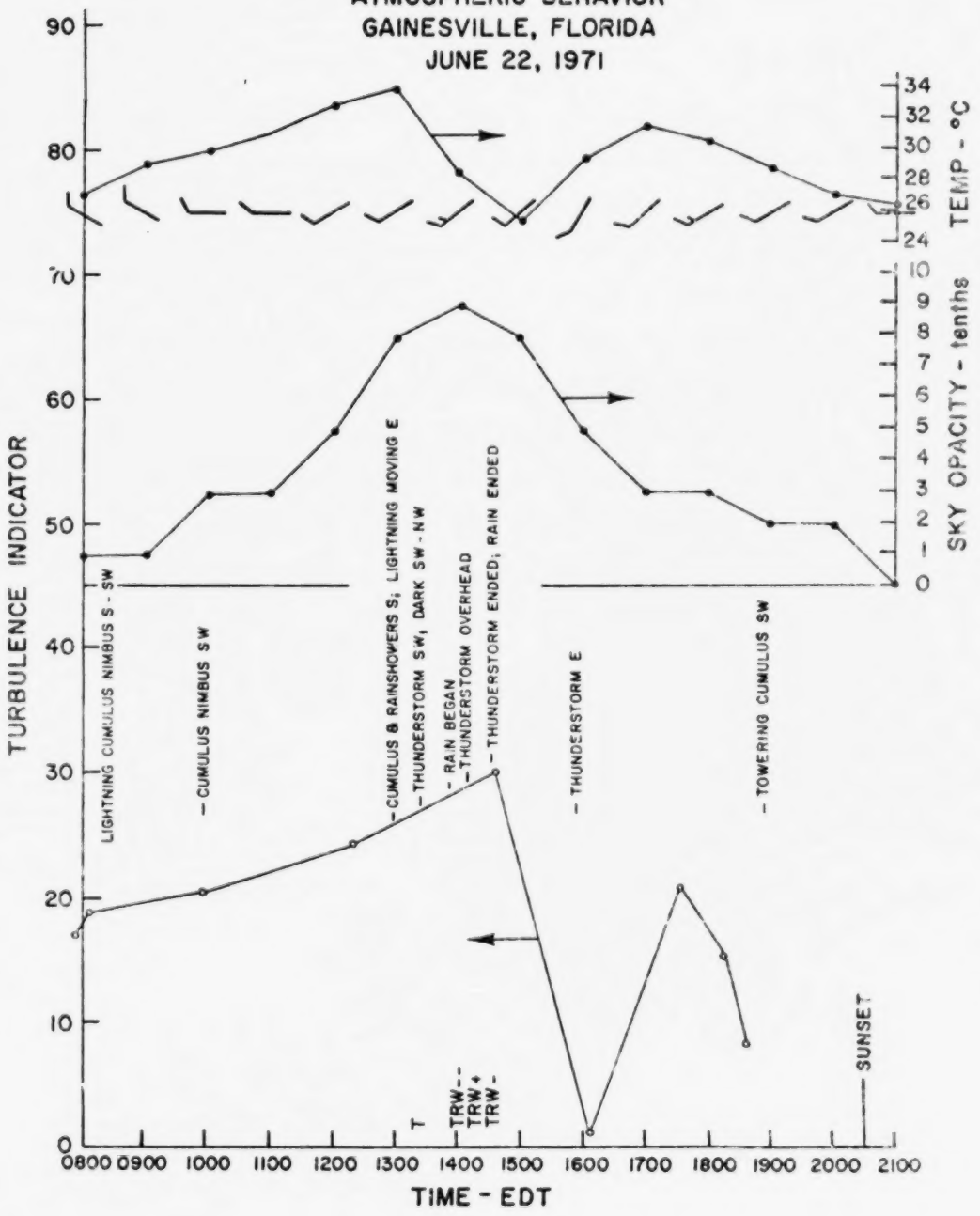
TYPE	TIME (LST)	SKY AND CEILING (Hundreds of Feet)	VISIBILITY (Statute Miles) Surface	VISIBILITY (Statute Miles) Tower	WEATHER AND OBSTRUCTIONS TO VISION	SEA LEVEL PRESS. (mb)	TEMP °F	DEW PT °F	WIND Direction (from Nearest 10°)	WIND Speed (Knots)	WIND Character	ALTIM. SETTING (Inches)	REMARKS AND SUPPLEMENTAL CODED DATA	STATION PRESSURE (mb)	DRY BULB °F	WET BULB °F	TOTAL AMT. OF PRECIP. (Inches)	TOTAL HRS. OF PRECIP.	OBSERVATION (GMT)
R	0056	0	7				67	57	00	00			/803 87		66.8	66.0	0	0	
R	0156	0	7				63	58	00	00					63.8	61.8	0	0	
R	0256	0	7				61	57	00	00					60.9	58.3	0	0	
R	0356	0	7				60	54	00	00			/402		59.9	57.1	0	0	
R	0456	0	6		HK		60	57	00	00					60.0	58.8	0	0	
R	0556	0	7				60	56	05	05					60.0	57.8	0	0	
R	0656	0	7+				65	62	11	06			/215 59		64.9	61.7	0	0	
R	0756	0	7+				74	61	01	00					73.6	62.4	0	0	
R	0856	0	7+				78	62	14	09					77.7	61.7	0	0	
R	0956	35 ⓞ	7+				80	63	14	08			/203		80.0	64.3	3	3	
R	1056	35 ⓞ	7+				83	63	16	09					82.4	64.3	3	3	
R	1156	E 35 ⓞ	7+				85	63	12	09					83.4	64.6	5	5	
R	1256	E 45 ⓞ	7+				86	66	17	09			/112 59		85.2	66.4	7	5	
R	1356	E 45 ⓞ	7+				87	67	19	09					87.3	68.7	6	6	
R	1456	45 ⓞ E 300 ⓞ	7+				88	68	19	12					87.9	69.6	6	4	
R	1556	45 ⓞ E 300 ⓞ	7+				86	68	19	10			/717		86.4	67.7	6	6	
R	1656	45 ⓞ 300 ⓞ	7+				84	68	19	13					85.8	68.9	5	4	
R	1756	300 ⓞ	7+				84	69	10	12					84.0	70.1	3	3	
R	1856	○	7+				81	69	12	13			/500 89		80.8	69.2	0	0	
R	1956	○	7+				78	69	11	10					77.9	68.4	0	0	
R	2056	○	7+				75	69	01	08					75.3	68.9	0	0	
R	2156	○	7+				74	68	10	07			/214		73.1	68.2	0	0	
R	2256	○	7+				73	69	12	06					73.0	68.8	0	0	
R	2356	○	7+				73	69	14	11					72.6	67.2	0	0	

June 22, 1971

The Florida weather of June 22, 1971 was dominated by a high pressure center located over the central section of the peninsula. Temperatures ranged from a high of 93 to a low of 73. Winds in the Gainesville area at about 18,000 feet were west to west-north-west at 20 knots.

This was a typical summer day in Florida with cumulus buildups leading to local thunderstorms in the early afternoon. All data reflect the cooling effect of shower activity. It is interesting to note the recovery of turbulence indicator and turbulent mixing height with clearing skies in the later afternoon hours and the collapse of this recovery at a time expected due to approaching sunset.

FIGURE 26.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
JUNE 22, 1971



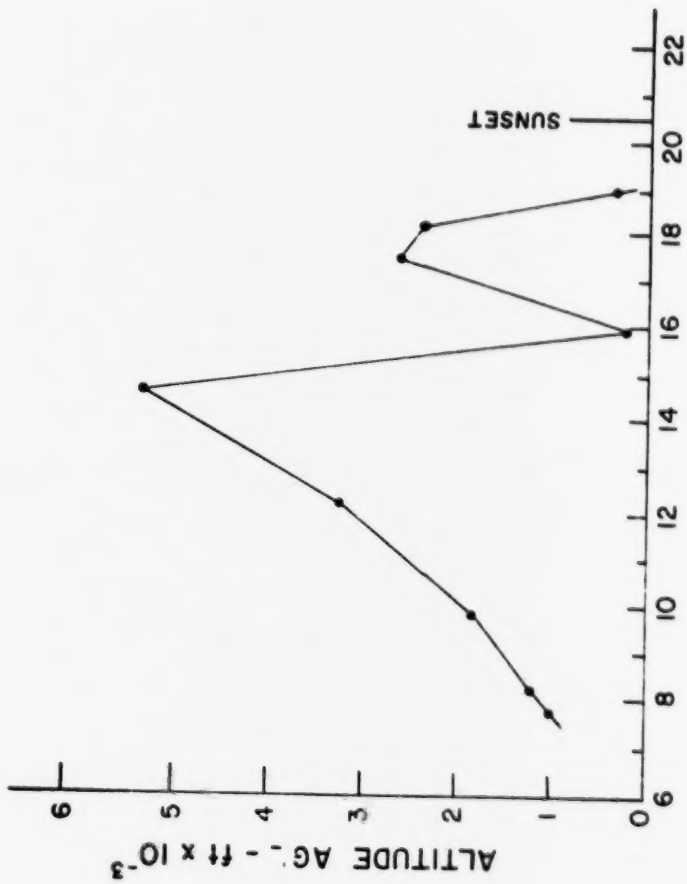


FIGURE 27.
TURBULENT MIXING HEIGHT
JUNE 22, 1971

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated Civil Stations)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

To convert LST to GMT: ADD _____ hrs. SUBTRACT _____ hrs.

STATION: FAA Gainesville, Fla.

DATE: June 22, 1971

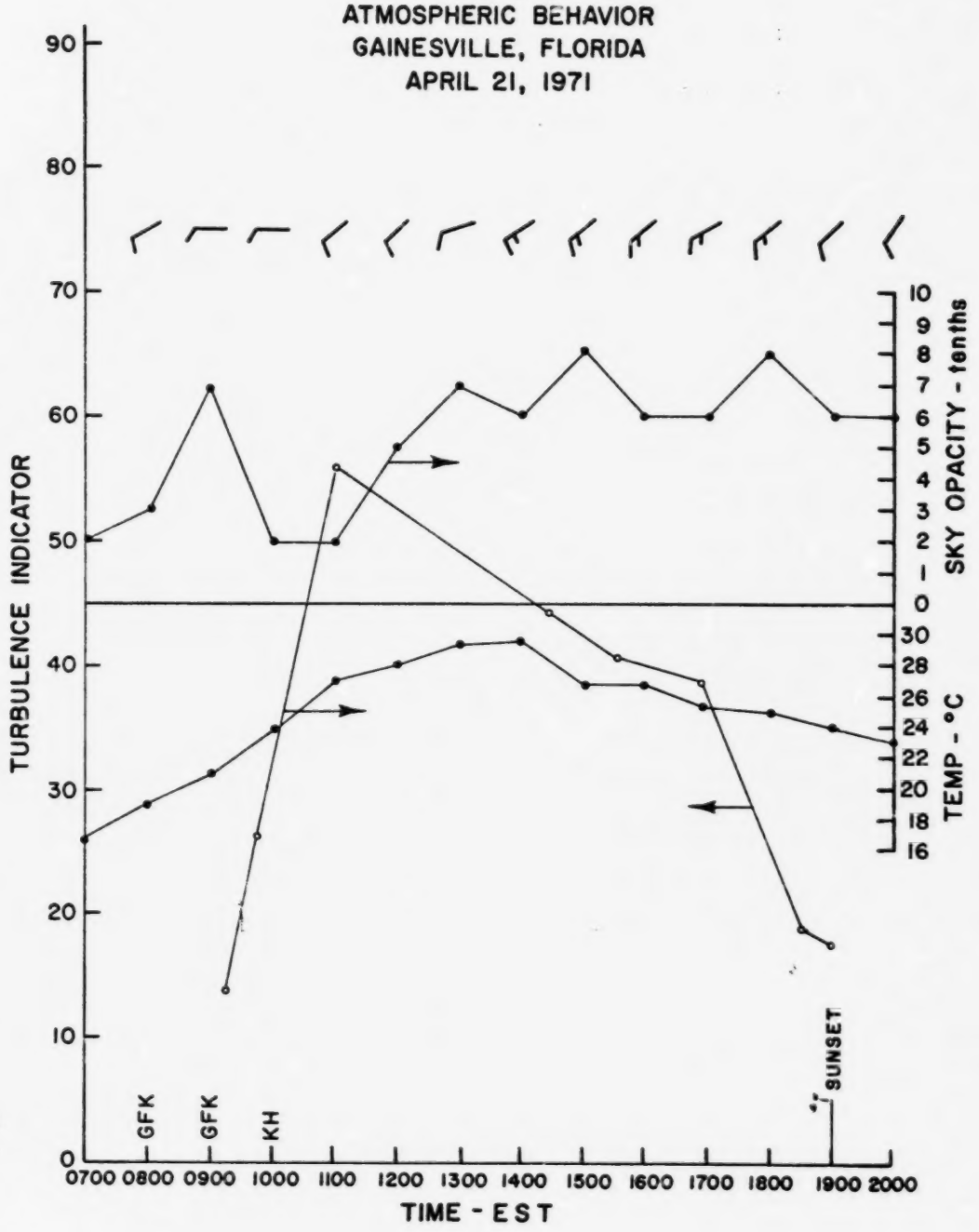
TYPE (1)	TIME (LST) (2)	SKY AND CEILING (Hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (4)	VISIBILITY (Statute miles) TOWER (4a)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS (mb) (6)	ITEM (7)	DEW PT (°F) (8)	WIND DIRECTION (10's) (9)	WIND SPEED (Knots) (10)	WIND CHARACTER (11)	ALTIM. SETTING (Ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (Ins.) (17)	DRY BULB (°F) (18)	WET BULB (°F) (19)	TOTAL SUN RADIATION LAST HOUR (Gram Cal) (20)	TOTAL SUN RADIATION LAST 24 HRS (Gram Cal) (21)	USER NEEDS (22)
R	0057	250 ⊕	7+				76	71	E 29	07			/ 80300 9H		76.0	72.3	4	3	
R	0158	250 ⊕	7+				74	72	E 31	07					74.4	72.4	5	4	
R	0257	250 ⊕	7+				73	70	E 21	06					73.3	71.3	5	4	
R	0358	250 ⊕	7+				75	72	E 27	05			/ 503		74.5	72.6	3	1	
R	0457	○	7+				76	73	E 25	07					75.7	73.7	0	0	
R	0557	○	7+				76	72	E 31	05			/ CB SW LTGCC		75.6	73.6	0	0	
R	0658	○	7+				73	73	E 26	07			/ 103 72		71.8	74.2	0	0	
R	0758	300 ⊕	7+				81	72	E 28	10					80.5	74.3	3	1	
R	0857	300 ⊕	7+				84	71	E 31	07			/ LN SW DSNT S-SW		83.7	72.1	3	1	
R	0958	300 120 ⊕ 3000	7+				86	71	E 27	10			/ CB DSNT SW / 109		86.1	76.3	5	3	
R	1058	300 ⊕ 300 ⊕	7+				88	71	E 21	10					87.9	76.2	5	3	
R	1156	E 400 ⊕ 300 ⊕	7+				91	70	E 24	10					90.2	76.0	6	3	
R	1256	E 40 ⊕	7+				93	69	E 24	09			/ CBRWH S LTGCCG MOVG E		92.3	76.2	5	2	
													71-4 72.						
S	1324	E 40 ⊕	7+		T				E 22	10	G		/ ILTGCG BW DSNT SW-NW TB 20				9	9	
RS	1358	E 25 ⊕ 120 ⊕ 250 ⊕	7+		TRW-		83	63	E 24	16			TB 20 RBSOT LTGCG S NW PRESNRHWRS		83.0	72.4	10	9	
S	1402	W 8 X	12		TRW+				E 25	15			TOWA LTGLG ALQDS (FIB)				10	10	
S	1408	E 30 ⊕ 120 ⊕ 250 ⊕	3		TRW-				E 22	12			T E-SE DSNT SE				10	10	
RS	1458	30 ⊕ 120 ⊕ 250 ⊕	7				78	15	E 24	05			/ IL 37 MOVD E TCUE RE25 SNR/WTR		78.3	76.2	10	8	
R	1556	120 ⊕ E 250 ⊕	7+				80	71	E 21	05			/ TCUE / E17		79.8	76.2	5	5	
R	1656	120 ⊕ 250 ⊕	7+				81	70	E 24	12					80.7	76.2	5	3	
R	1755	120 ⊕ 250 ⊕	7+				81	70	E 25	13					80.8	76.2	5	3	
R	1856	250 ⊕	7+				82	70	E 24	13			/ TCU SW/ 0003H 93		79.6	76.2	3	2	
R	1955	250 ⊕	7+				81	71	E 22	12					81.1	76.2	3	2	
R	2052	○	7+				80	71	E 21	11			TCU CU SW		79.3	76.2	0	0	
R	2156	○	7+				78	73	E 31	06			/ CCNL MTGR DSNT NSW / 310		77.6	76.2	0	0	
R	2256	○	7+				76	72	E 32	04					76.0	73.6	0	0	
R	2356	○	7+				77	72	E 31	05					76.6	73.6	0	0	

April 21, 1971

On April 21, 1971, a weak high pressure system centered approximately 400 miles southeast of the southern tip of the Florida peninsula dominated the Gainesville weather. Surface winds were light due to the weak pressure gradient and generally, southwesterly. Dew points were in the sixties and some ground fog occurred during the morning hours which quickly burned off. The maximum temperature attained was 85 and the low 59. The low level winds bringing moisture off the Gulf produced considerable cloudiness during the day. Winds at 15,000 feet were about 300°, at 25 knots. No precipitation occurred at Gainesville during the 24-hour period.

The above cloudiness appeared at Gainesville just prior to noon. This increase in cloud cover stunted the continued increase in turbulence indicator and turbulence mixing height. In spite of the cloud cover however these two parameters experienced the rapid collapse in the hours preceding sunset.

FIGURE 28.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
APRIL 21, 1971



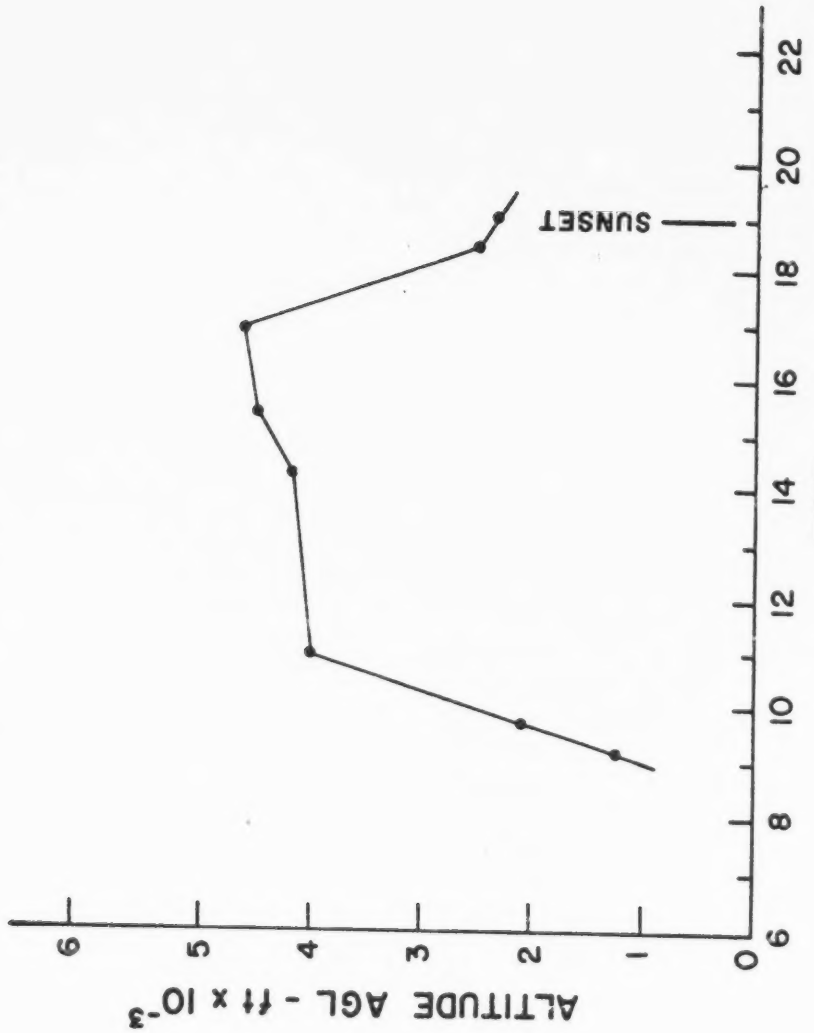


FIGURE 29.
TURBULENT MIXING HEIGHT
APRIL 21, 1971

NPL-10C
12-71

To convert LST to GMT
ADD ____ hrs SUBTRACT ____ hrs

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated Local Stations)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

STATION: FAA Gainesville, Fla
DATE: April 21, 1971

TYPE (1)	TIME (LST) (2)	SKY AND CEILING (Hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (4)	VISIBILITY (Statute miles) TOWER (4a)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS (mb) (6)	TEMP (°F) (7)	DEW PT (°F) (8)	WIND DIRECTION (00-36) (9)	WIND SPEED (Kts) (10)	WIND CHARACTER (11)	ALTIM. SETTING (Ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (Ins.) (17)	DRY BULB (°F) (18)	WET BULB (°F) (19)	TOTAL SKY COVER (21)	TOTAL OPAQUE SKY COVER (22)	OBSERVERS INITIALS (23)
R	0058	O	5		KH		65	61	24	03			/810 88		65.4	62.8	0	0	
R	0156	O	5		KH		65	61	27	08					65.1	62.7	0	0	
R	0356	O	5		KH		64	61	27	07					63.8	62.1	0	0	
R	0357	O	5		KH		63	60	22	06			/620		63.2	61.5	0	0	
R	0456	O	4		KH		62	60	27	04					62.3	60.9	0	0	
R	0557	O	3		KH		61	59	00	00					61.2	60.0	5	2	
RS	0658	-X 250 ⊕	1½		GFK		60	60	00	00			/6F2 314 59		61.1	60.1	5	2	
S	0718	-XE 250 ⊕	1		GFK		—		00	00									
R	0756	-XE 250 ⊕	1		GFK		67	64	24	10			/GFK 65		66.8	65.7	5	3	
S	0827	-XE 250 ⊕	1¼		GFK		—		27	07			/GFK 4 /STFRA				6	4	
S	0832	-XE 250 ⊕	1½		GFK		—		27	08			/GFK 4 /STFRA						
RS	0856	84 ⊕	2½		GFK		70	66	27	08									
S	0919	5 ⊕	3		GFK		—		27	11					100	67.8	8	7	
R	0956	5 ⊕ 100 ⊕	5		KH		75	62	26	10			/303						
RS	1056	25 ⊕	7+				81	61	23	10					75.2	66.2	3	2	
R	1156	E 30 ⊕ 250 ⊕	7+				83	62	23	10					78.0	67.8	3	2	
R	1253	E 40 ⊕ 250 ⊕	7				85	62	210	21			/814 59		82.8	69.0	9	5	
R	1357	35 ⊕ 250 ⊕	7				85	63	2115	23					85.0	70.3	9	7	
R	1457	35 ⊕ E 250 ⊕	7				80	61	24	16					84.9	70.2	9	6	
R	1558	35 ⊕ E 250 ⊕	7+				80	61	24	1416	23		/714		80.4	67.6	10	8	
R	1657	35 ⊕ E 250 ⊕	7+				78	61	24	1416	20				80.0	68.9	9	6	
R	1758	35 ⊕ E 250 ⊕	7				77	63	25	15					78.0	67.0	9	6	
R	1857	E 250 ⊕	7				75	65	25	12			/803 85		76.9	67.1	10	8	
R	1956	E 250 ⊕	7				79	64	33	10					75.0	68.0	9	6	
R	2058	12 ⊕ E 250 ⊕	5		KH		71	66	22	10					73.3	67.6	8	6	
															71.3	67.9	7	6	

MF1-10C (3-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated Civil Stations)

To convert LST to GMT
ADD _____ hrs SUBTRACT _____ hrs

STATION: FAA Gainesville, Fla

DATE: April 21, 1971

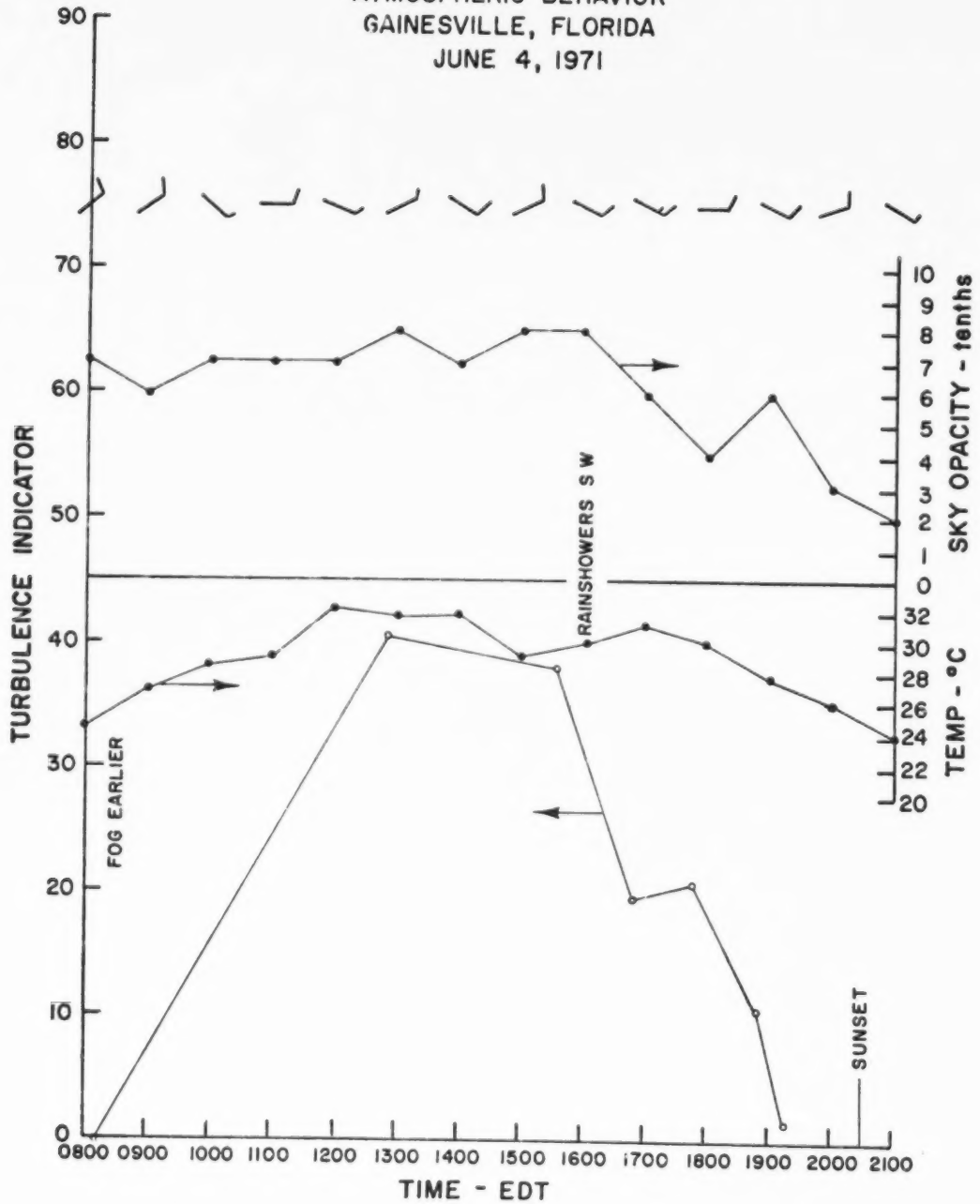
TYPE (1)	TIME (LST) (2)	SKY AND CEILING (Hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (5)	VISIBILITY (Statute miles) TOWER (5a)	WEATHER AND OBSTRUCTIONS TO VISION (6)	SEA LEVEL PRESS (mb.) (8)	TEMP °F (7)	DEW PT °F (8)	WIND DIRECTION (10-36) (9)	WIND SPEED (kts.) (10)	WIND CHARACTER (11)	ALTIM SETTING (ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (ins.) (17)	DRY BULB °F (18)	WET BULB °F (19)	TOTAL SKY COVER (20)	TOTAL OPAQUE SKY COVER (21)	OBSERVER'S INITIALS (22)
RS	2158	9 ⊘ E 250 ⊘	3		K H		70	67	24	10			/⊘ V ⊘ /210		70.1	68.1	9	7	
S	2215	M9 ⊘ 250 ⊘	3		K H		—		24	10					—	—	—	—	
R	2257	M 8 ⊘ 250 ⊘	3		K H		70	67	24	09					70.1	68.1	10	9	
R	2358	M 9 ⊘ 250 ⊘	3		K H		69	67	22	07					69.2	68.0	8	8	

June 4, 1971

On June 4, 1971, the southeastern United States was dominated by a large but weak high pressure system. The high had two centers, one over eastern Kentucky and the other over eastern South Carolina. This put the Gainesville area on the southern part of the high and surface winds during the day were easterly. Considerable low level moisture caused some patchy ground fog in the early morning which soon dissipated due to the dryness of the upper air. Winds aloft were very light and variable. At approximately 18,000 feet, winds were easterly at 5 knots or less. No precipitation occurred at Gainesville during the preceding 24-hours and the temperature ranged from a high of approximately 90 to a low of 68.

Considerable cloud cover was experienced all day. The turbulence indicator data reflect a brief effect of a local rainshower. The rate of collapse of turbulence indicator and turbulent mixing height is less than experienced on a clear day.

FIGURE 30.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
JUNE 4, 1971



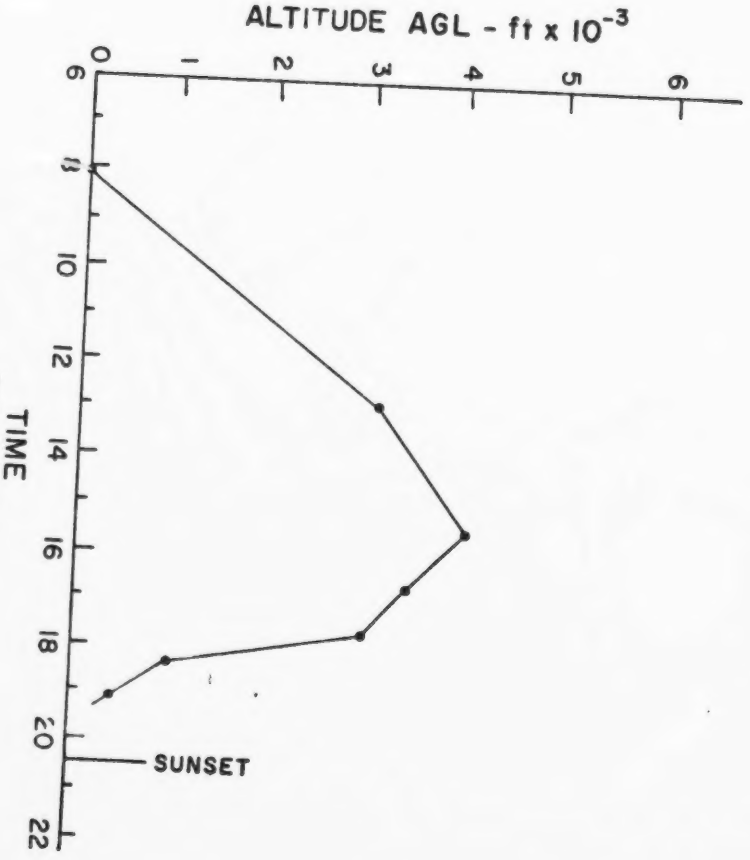


FIGURE 31.
TURBULENT MIXING HEIGHT
JUNE 4, 1971

MP1-10C
(2-71)

To convert LST to GMT
ADD ____ hrs SUBTRACT ____ hrs

SURFACE WEATHER OBSERVATIONS
(Abridged for use at designated Civil Stations)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

STATION: FAA Gainesville, Fla.
DATE: June 4, 1971

TYPE (1)	TIME (L.S.T.) (2)	SKY AND CEILING (Hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (4)	VISIBILITY (Statute miles) TOWER (4a)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS (mb) (6)	TEMP (°F) (7)	DEW PT (°F) (8)	WIND DIRECTION (9)	WIND SPEED (kts.) (10)	WIND CHARACTER (11)	ALTIM SETTING (ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (ins.) (17)	DRY BULB (°F) (18)	WET BULB (°F) (19)	TOTAL SKY COVER (1)	TOTAL OPAQUE SKY COVER (15)	OBSERVER'S INITIALS (16)
R	0051	O	7+				70	69	06	06			/710 89		70.3	69.3	0	0	
R	0158	O	7+				69	68	06	04					69.4	69.4	0	0	
R	0257	O	4		GF		69	68	04	04					69.1	68.3	0	0	
RS	0358	O	2		GF		68	67	05	06			/500		67.7	67.2	0	0	
RS	0457	- X	3/4		G,F		70	67	05	04			/F2		69.9	69.6	2	7	
RS	0557	-X v35 35 Ø	1/2		F		70	68	06	06			/F6		70.0	69.3	6	6	
RS	0655	-X	1		GF		72	71	07	05			/F4/ 210 68		72.0	71.0	4	4	
S	0701	300-Ⓓ	3		GF		—	—	07	06			/Few Scud S HND		—	—			
RS	0755	BS Ⓓ	7+				76	72	05	10					76.0	73.0	5	7	
S	0812	8Ⓓ 300-Ⓓ	7+						06	08					—	—	5	2	
RS	0855	A 12Ⓓ 300Ⓓ	7+				81	69	08	07					81.0	72.8	7	6	
R	0956	E 12Ⓓ 300Ⓓ	7+				83	69	12	07			/ 107		83.0	73.0	7	7	
R	1058	E 25Ⓓ 300Ⓓ	7+				84	67	09	09					84.0	72.5	7	7	
RS	1158	E 30Ⓓ 300Ⓓ	7+				90	68	10	07					90.0	73.5	7	7	
R	1259	E 30Ⓓ 300Ⓓ	7+				89	66	06	07			/ 717 68		88.9	73.2	8	8	
R	1358	E 35Ⓓ	7+				86	64	11	08					86.3	72.3	7	7	
R	1458	E 35Ⓓ	7+				84	61	06	12					83.6	69.3	8	8	
R	1556	30Ⓓ E 50Ⓓ	7+				86	66	10	10			/RWV SW/ 717		85.1	72.2	8	8	
R	1658	35Ⓓ E 60Ⓓ	7+				88	64	10	15					88.2	72.0	6	6	
R	1758	35Ⓓ 50Ⓓ 300Ⓒ	7+				84	64	09	10					85.5	70.1	7	7	
R	1854	50Ⓓ 120Ⓓ 300Ⓒ	7+				83	64	10	08			/ 307 90		83.3	70.9	9	6	
R	1958	120Ⓓ 350Ⓒ	7+				79	66	08	08					79.0	70.1	9	3	
R	2056	300Ⓓ	7+				76	66	11	04					76.3	69.3	3	3	
R	2158	300-Ⓓ	7+				74	67	10	05			/ 110		73.7	70.5	2	2	
R	2257	300Ⓓ	7+				71	67	00	00					70.3	69.3	2	1	
R	2357	O	7+				71	67	00	00					69.9	69.0	0	0	

June 15, 1971

June 15, 1971 was a typical summer meteorological situation. The Bermuda high extended into the Gulf of Mexico with high pressure centered about 300 miles south of New Orleans. The surface circulation was generally south to southwest bringing in considerable moisture. The winds at about 18,000 feet over Gainesville were northwesterly during the day, at 10 knots or less. The temperature regime ranged from a high of 93 to a low of 73.

A truly cloudy day with considerable rain and thunderstorm activity. These activities led to the reduction of turbulence indicator and turbulent mixing height at an early hour. Surface temperatures dramatically reflect the thundershower cooling effect. It should be appreciated that turbulence surely existed in and near these thundershowers. Aircraft operations were continued "in between" such formations.

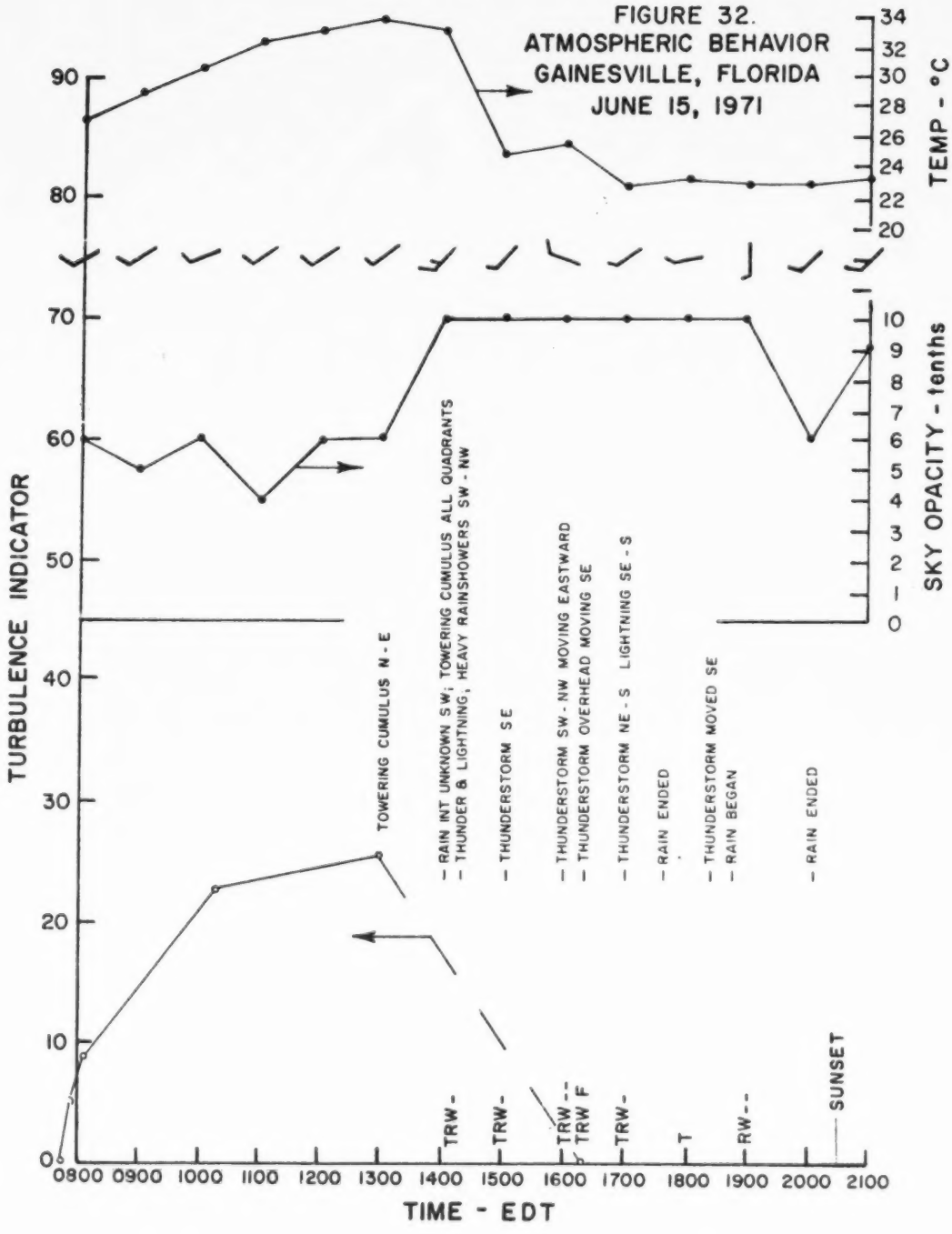


FIGURE 32.
ATMOSPHERIC BEHAVIOR
GAINESVILLE, FLORIDA
JUNE 15, 1971
TURBULENCE INDICATOR
TEMP - °C
SKY OPACITY - tenths
TIME - EDT
0800 0900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100
TOWERING CUMULUS N - E
- RAIN INT UNKNOWN S W; TOWERING CUMULUS ALL QUADRANTS
- THUNDER & LIGHTNING, HEAVY RAINSHOWERS SW - NW
- THUNDERSTORM S E
- THUNDERSTORM SW - NW MOVING EASTWARD
- THUNDERSTORM OVERHEAD MOVING SE
- THUNDERSTORM NE - S LIGHTNING SE - S
- RAIN ENDED
- THUNDERSTORM MOVED SE
- RAIN BEGAN
- RAIN ENDED
TRW -
TRW -
TRW --
TRW F
TRW -
T
RW --
SUNSET

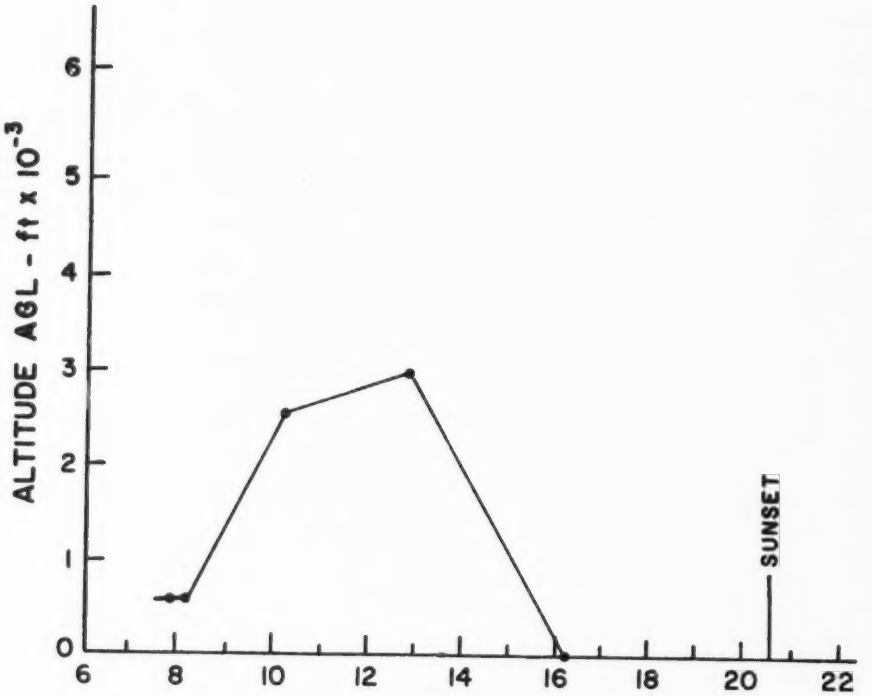


FIGURE 33.
TURBULENT MIXING HEIGHT
JUNE 15, 1971

NP1-10C
(2-71)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

SURFACE WEATHER OBSERVATIONS

(Abridged for use at designated Local Stations)

To convert LST to GMT
ADD _____ hrs SUBTRACT _____ hrs

STATION: FAA Gainesville, Fla.

DATE: June 15, 1971

TYPE (1)	TIME (LST) (2)	SKY AND CEILING (Hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (4a)	VISIBILITY (Statute miles) TOWER (4b)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS (mb) (6)	TEMP °F (7)	DEW PT °F (8)	WIND DIRECTION (Tens of degrees) (9)	WIND SPEED (Kts) (10)	WIND CHARACTER (11)	ALTIM SETTING (Ins.) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (ins.) (17)	DRY BULB °F (18)	WET BULB °F (19)	TOT. CLD AMT (20)	LOW CLD AMT (21)	LOW CLD TYPE (22)	MID CLD TYPE (23)	HIGH CLD TYPE (24)	OBSERVERS INITIALS (25)
R	0056	100 Ⓓ E 250 Ⓓ	4		GF		78	77	26	10	E		/ 602 94		77.8	76.9	10	10				
R	0156	100 Ⓓ E 250 Ⓓ	4		GF		78	77	26	09	E				77.5	76.8	10	8				
RS	0256	E 250 Ⓓ	2		GF		77	76	26	01	E				77.2	76.4	10	8				
R	0355	E 250 Ⓓ	2		GF		77	76	26	01	E		/ 500		77.2	76.6	10	7				
R	0455	E 250 Ⓓ	2		GF		77	76	26	08	E				77.0	76.1	5	6				
RS	0557	B 5 Ⓓ 250 Ⓓ	1½		GF		77	76	24	08	E		/ Ⓓ V Ⓓ		77.3	76.5	10	10				
RS	0658	E 60 Ⓓ 250 Ⓓ	2		GF		74	72	23	10	E		/ 24 76 2074		78.6	77.4	3	7				
R	0733	E 6 Ⓓ	3		GFK		—	—	23	05	E		/ Ⓓ V Ⓓ		—	—	6	5				
RS	0758	E 10 Ⓓ	4		K		81	78	24	10	E				81.0	78.7	7	6				
R	0858	A 12 Ⓓ	7				84	78	E 25	10			/ Ⓓ V Ⓓ		84.2	79.9	6	5				
R	0858	A 18 Ⓓ 250 Ⓓ	7+				87	76	E 26	08			/ 15 Ⓓ V Ⓓ / 103		87.2	79.6	8	6				
RS	1058	20 Ⓓ 250 Ⓓ	7+				90	76	E 26	10					90.0	80.0	8	4				
R	1055	25 Ⓓ E 250 Ⓓ	7+				91	76	E 26	10					92.8	79.9	8	6				
R	1256	30 Ⓓ E 250 Ⓓ	7+				93	76	E 24	06			/ TCUN-E 607 76		93.4	80.3	7	6				
R	1357	E 30 Ⓓ 250 Ⓓ	7+				91	74	E 23	16			/ RWU SW TCU ALQDS		91.3	78.5	10	10				
S	1410	E 30 Ⓓ 120 Ⓓ 25 Ⓓ	4		TRW-				E 26	16	G 18		TB09 T LTGCG RWU SW-NW		—	—	10	10				
R	1457	E 25 Ⓓ 120 Ⓓ 250 Ⓓ	6		TRW-		77	73	E 26	05			/ TSE		76.9	73.3	10	10				
R	1557	E 30 Ⓓ 120 Ⓓ 250 Ⓓ	6		TRW-		78	74	E 28	10	G 24		/ 610 TSW-NW MOVGE LTGCG SW		79.9	75.1	10	10				
S	1608	E 30 Ⓓ 120 Ⓓ	2½		TRW-				E 28	10			/ T SW-NW MOVGE		—	—	10	10				
S	1611	W 10 X	1		TRW F				E 25	10			/ T OVHD MOVG SE		—	—	10	10				
S	1631	E 12 Ⓓ 25 Ⓓ	3		TRW				E 28	10	G 20		/ T E-SE				10	10				
RS	1656	12 Ⓓ E 26 Ⓓ 100 Ⓓ	4		TRW-		73	71	E 24	05			/ TNE-S LTGCG SE-S TWR PK WND 02/40 03		72.7	71.2	10	10				
RS	1757	E 30 Ⓓ 120 Ⓓ	6		T		74	69	E 24	06			/ RE 33 ISE MOVG SE		73.7	70.6	10	10				
RS	1856	30 Ⓓ 120 Ⓓ E 250 Ⓓ	7		RW-		73	70	E 18	06			/ TE 38 MOVD SE RB42/		73.4	71.0	10	10				
													/ 210 67 94									
R	1957	120 Ⓓ E 250 Ⓓ	7				73	69	E 24	05			/ RE 06		73.0	70.2	7	6				
R	2056	E 120 Ⓓ 250 Ⓓ	7+				74	70	E 24	10					73.7	71.1	10	9				
R	2157	120 Ⓓ 250 Ⓓ	7+				73	71	E 24	10			/ 217		73.2	71.8	3	3				
R	2258	120 Ⓓ 250 Ⓓ	7+				75	73	E 24	08					74.8	73.45	4					

WBAN-10C
(2-71)

To convert LST to GMT
ADD ____ hrs. SUBTRACT ____ hrs.

SURFACE WEATHER OBSERVATIONS
(Abridged for use at designated Civil Stations)

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

STATION: FAA Gainesville, Fla.
DATE: June 15, 1971

TYPE (1)	TIME (L.S.T.) (2)	SKY AND CEILING (Hundreds of feet) (3)	VISIBILITY (Statute miles) SURFACE (4)	VISIBILITY (Statute miles) TOWER (4a)	WEATHER AND OBSTRUCTIONS TO VISION (5)	SEA LEVEL PRESS (mb.) (6)	TEMP (°F) (7)	DEW PT. (°F) (8)	WIND DIRECTION (Deg. Tens) (9)	WIND SPEED (Knots) (10)	WIND CHARACTER (11)	ALTIM. SETTING (Inches) (12)	REMARKS AND SUPPLEMENTAL CODED DATA (13)	STATION PRESSURE (Inches) (17)	DRY BULB (°F) (18)	WET BULB (°F) (19)	TOTAL SKY COVER (20)	TOTAL OPAQUE SKY COVER (36)	OBSERVERS INITIALS (15)
B	2338	120 Ⓓ E 250 Ⓓ	7				76	74	E	22	10				75.5	74	9	7	

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CHANGE IN LAPSE RATES DURING COLLAPSE PERIOD

Lapse rates for the days and hours involved in the study are summarized in Table I. These rates were determined within the mixing layer, usually from 200' to 2200' above the surface. During the late hours the mixing layer is ill-defined due to the very rapid collapse being experienced; in which case the above system of determining this rate was used; i.e. no attempt was made to restrict the lapse rate determination to a height within the mixing layer. While there are large deviations, it would seem that the lapse rate becomes more stable with the approach of sunset.

TABLE I

Mixing Height Lapse Rates
with Approach of Sunset

Date	Time	Time of Sunset	Lapse Rate °C/100 M
01/21/71	1605	1757	0.917
	1810		0.753
09/13/71	1315	1949	0.973
	1530		0.918
	1730		0.868
	1820		0.835
	1855		0.835
03/18/71	1340	1838	0.902
	1535		0.933
	1655		0.737
	1750		0.836
	1840		0.737
09/14/71	1440	1949	0.983
	1630		0.885
	1740		0.885
	1825		0.738
03/24/71	1410	1843	0.885
	1530		1.00
	1855		1.05
04/21/71	1420	1900	0.852
	1530		0.836
	1650		0.786
	1830		0.770
	1855		0.606
11/17/70	1110	1745	1.00
	1620		0.352
	1750		0.902
05/05/71	1010	1909	0.787
	1405		0.860
	1550		0.590
	1815		0.830
	1945		0.787
05/07/71	1010	1910	0.750

TABLE I
Continued

	1320		0.967
	1500		1.007
	1630		1.065
	1830		1.190
	1850		0.950
	1920		0.885
	1955		0.935
05/24/71	1035	1921	0.983
	1310		0.983
	1545		1.000
	1730		1.037
	1840		0.871
	1915		1.037
	1925		0.837
05/31/71	1350	1923	0.904
	1650		0.960
	1810		0.950
	1930		0.917
06/04/71	1245	1925	0.721
	1530		0.902
	1640		0.787
	1750		0.982
06/15/71	1010	1931	0.819
	1110		0.950
	1300		1.068
	1630		0.640
06/22/71	1000	1932	0.492
	1210		0.982
	1425		0.862
	1600		0.656
	1730		0.852
	1815		0.819

MAPPING OF MIXING HEIGHT OVER URBAN AREAS

Attempts were made to map the mixing height over Atlanta on 3/24/71; over Jacksonville, Florida on 12/11/71 and Tampa, Florida on 12/12/71. The first two showed very little in the way of a heat island. The data of 12/12/71 at Tampa, however, did reveal such an effect, with an increase in the upper limit of turbulence on the order of 400-500 feet. These data were taken approximately 3-4 hours before sunset at which time the turbulent mixing should have been at its maximum. Weather was clear with widely scattered clouds over the downtown area. This procedure was found to be very difficult from an operational point of view. For any future work in this area a different approach would be suggested, such as examining the turbulence indicator amplitude at some uniform altitude while quickly traversing the urban area in downwind and cross-wind directions.

DIURNAL VARIATION OF TURBULENCE INDICATOR WITH HEIGHT

As explained in Figure 3, in the reduction of data the turbulence indicator was evaluated at 200 foot intervals for each sounding and an integrated value for the sounding used for diurnal plotting purposes. Absent from this system is any indication of the behavior of turbulence as evidenced by this "turbulence indicator" as a function of height above the earth's surface. These data are too numerous to present here in their entirety. Generally this turbulence indicator, and therefore turbulence, was greatest at or near the surface with a progressive reduction up to the limit of turbulent mixing. Also the magnitude of this indicator increased with time throughout the active mixing layer, maintaining the reduction in magnitude with height, until that time of day when the inverse process or decay began. During the decay period, the general period pattern was that the magnitude of turbulence decreased at all levels, with the near surface levels maintaining the largest although decreasing magnitudes until virtually all the energy had dissipated and no significant turbulence was measurable. These phenomena are illustrated in Figures 34 through 41. The apparent discontinuities or departures from a linearly reducing magnitude with height are attributed to the cell structure of atmospheric mixing combined with the fact that the aircraft was moving through the mobile system rather than sounding in a strictly vertical path.

FIGURE 34.
DIURNAL VARIATION OF TURBULENCE
WITH HEIGHT
24 MARCH 1971
ATLANTA, GEORGIA

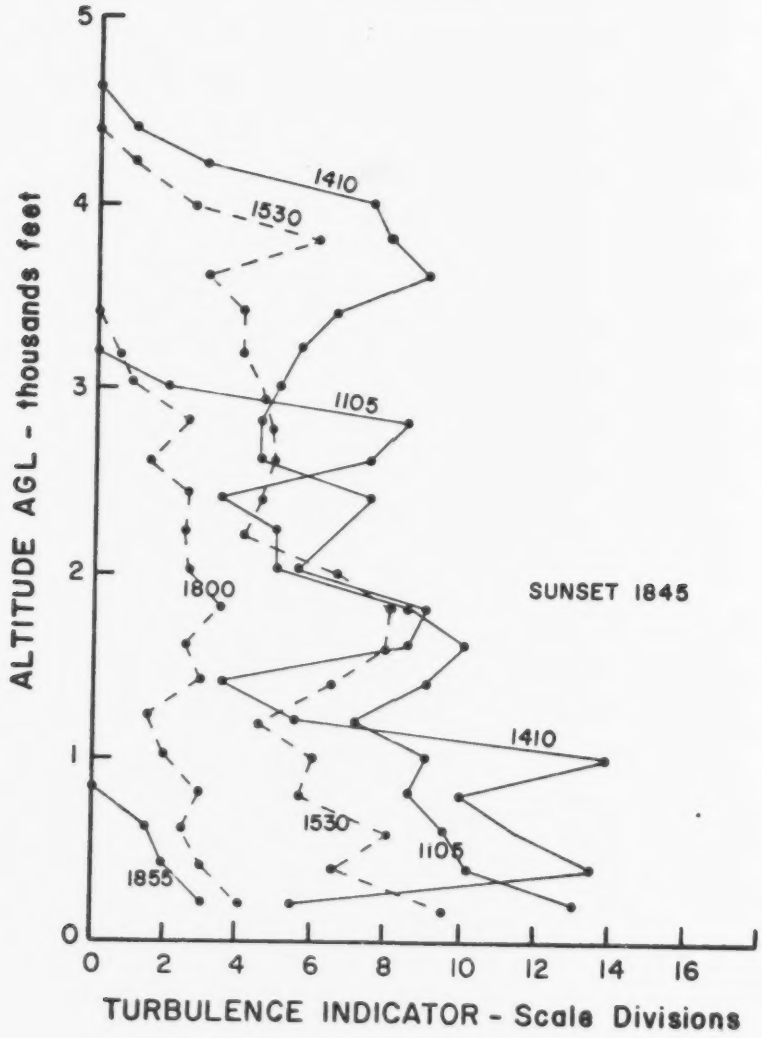


FIGURE 35.
DIURNAL VARIATION OF TURBULENCE
AT GIVEN ALTITUDE
24 MARCH 1971
ATLANTA, GEORGIA

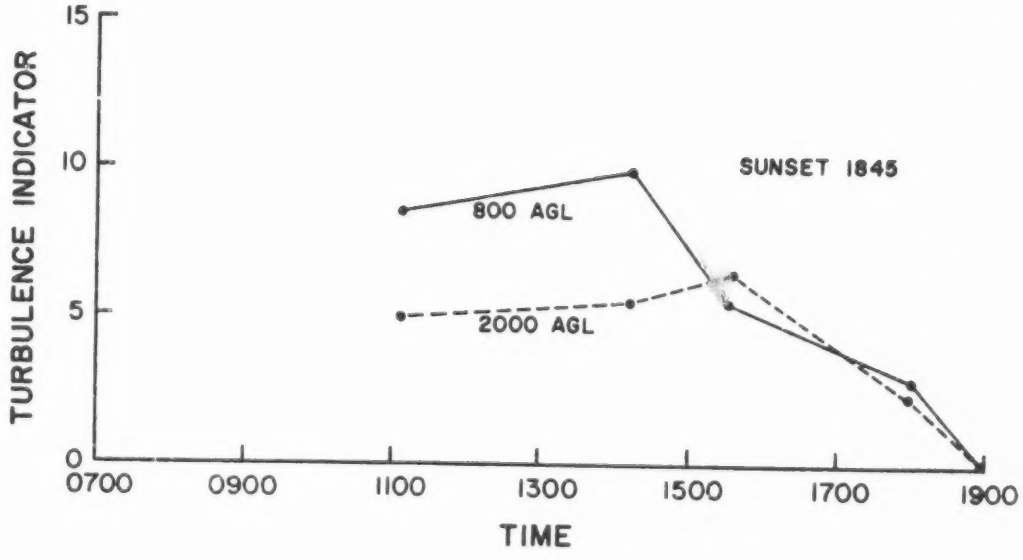


FIGURE 36.
DIURNAL VARIATION OF TURBULENCE
WITH HEIGHT
17 NOVEMBER 1970
GAINESVILLE, FLORIDA

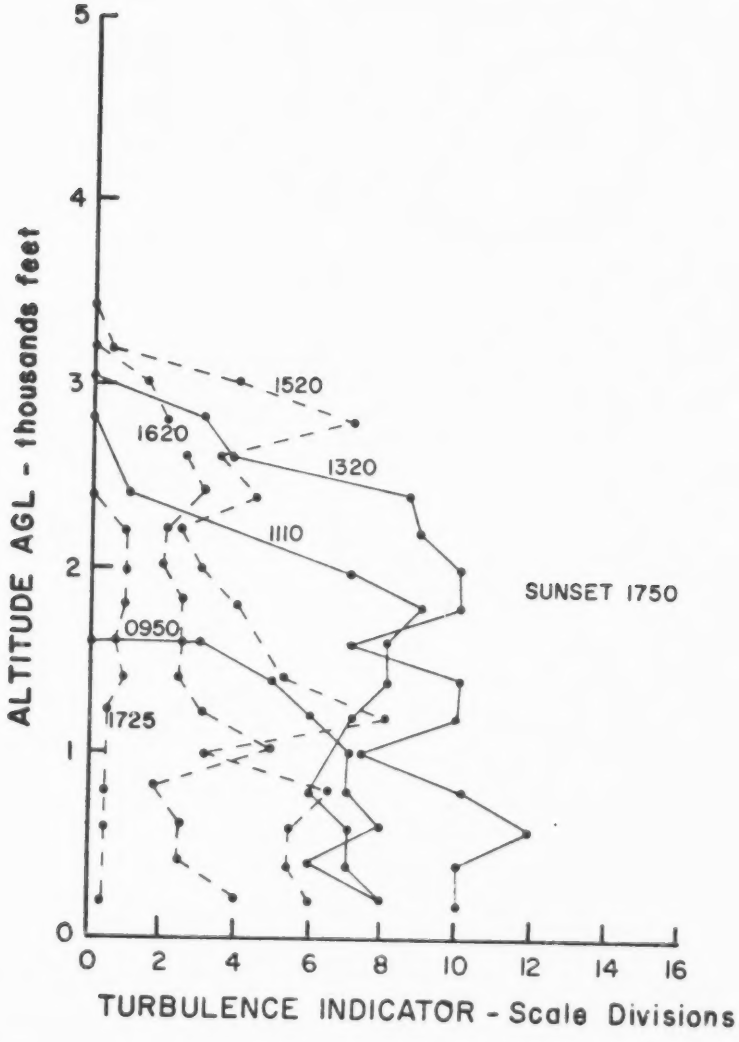


FIGURE 37.
DIURNAL VARIATION OF TURBULENCE
AT GIVEN ALTITUDE
17 NOVEMBER 1970
GAINESVILLE, FLORIDA

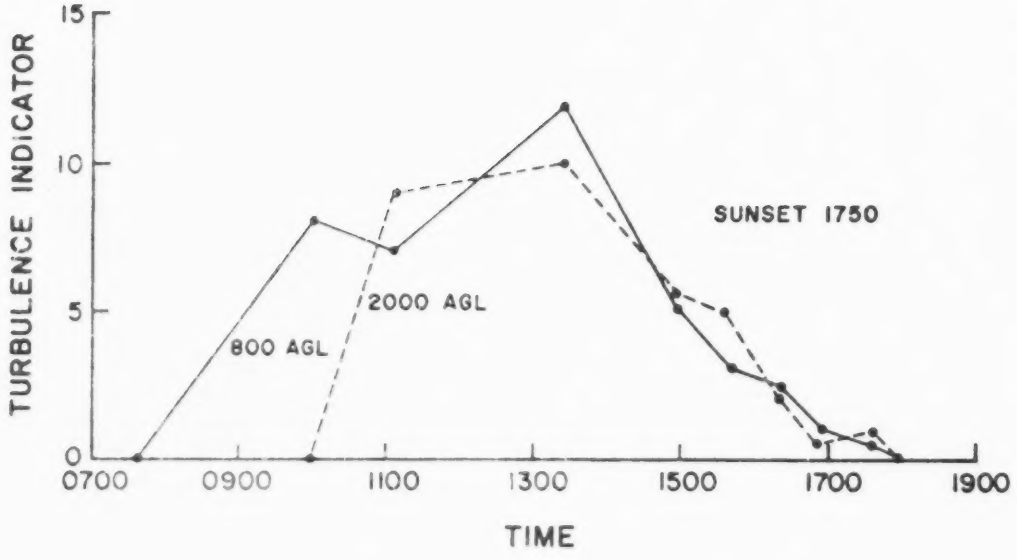


FIGURE 38.
DIURNAL VARIATION OF TURBULENCE
WITH HEIGHT
21 APRIL 1971
GAINESVILLE, FLORIDA

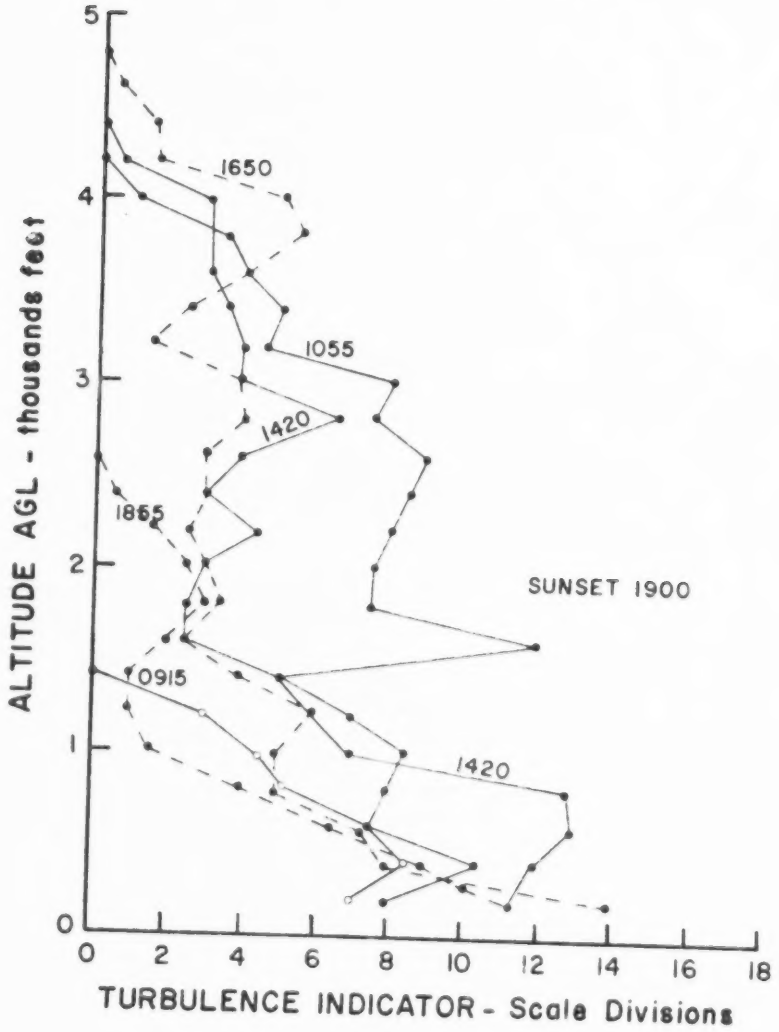


FIGURE 39.
DIURNAL VARIATION OF TURBULENCE
AT GIVEN ALTITUDE
21 APRIL 1971
GAINESVILLE, FLORIDA

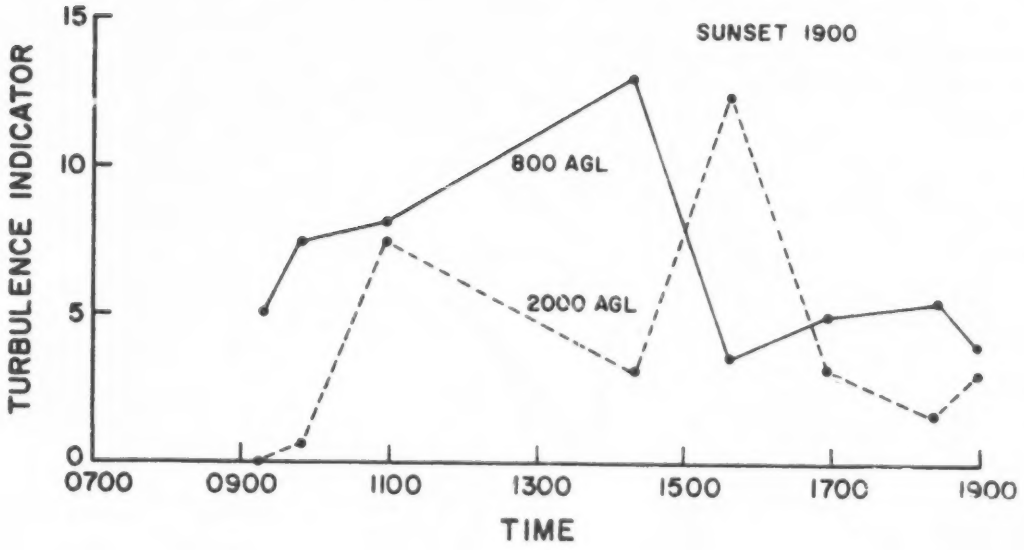


FIGURE 40.
DIURNAL VARIATION OF TURBULENCE
WITH HEIGHT
18 MARCH 1971
GAINESVILLE, FLORIDA

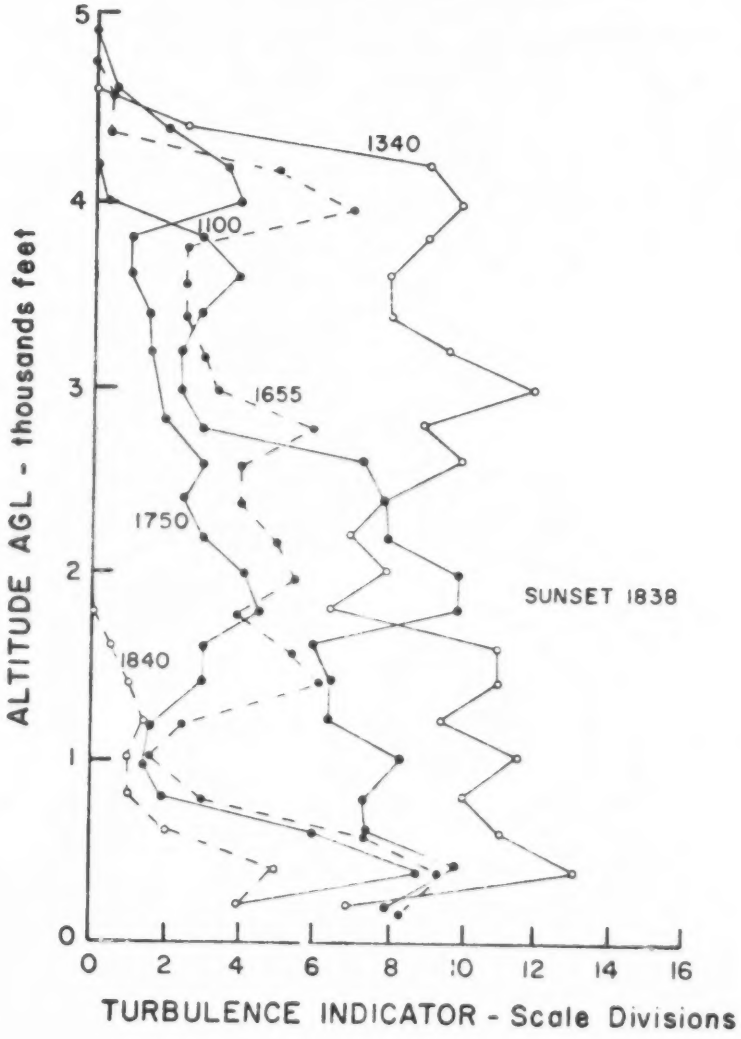
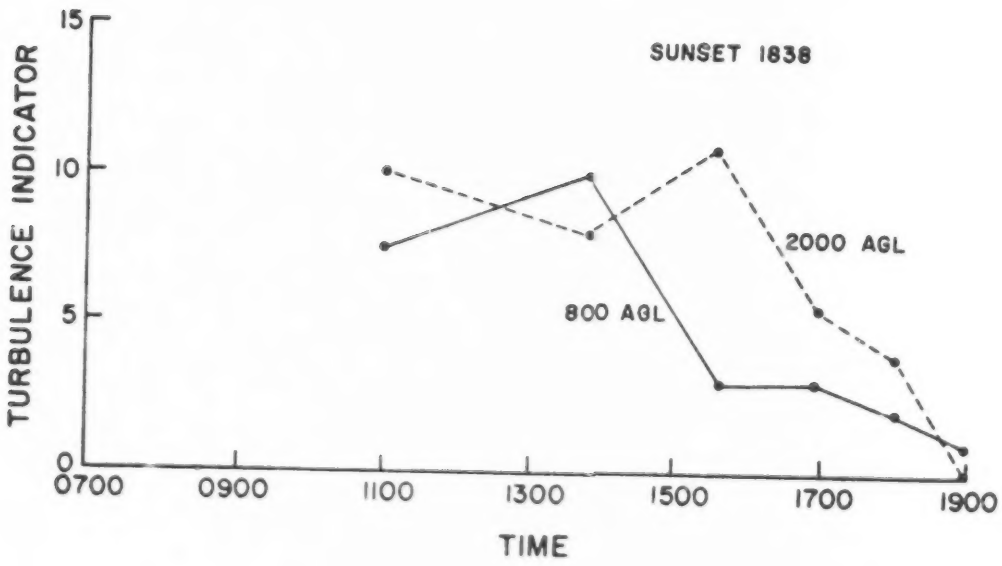


FIGURE 41.
DIURNAL VARIATION OF TURBULENCE
AT GIVEN ALTITUDE
18 MARCH 1971
GAINESVILLE, FLORIDA



CORRELATION OF MEASURED AND PREDICTED MIXING HEIGHTS

Using those days for which an early morning temperature sounding existed, a correlation was established between the measured turbulent mixing height and that predicted by the Holzworth technique, similar to the study of reference 1 . Anticipating poor results during the late afternoon period of turbulent energy decay, the study was partitioned into an examination of data taken prior to the beginning of the decay and that taken after this point in time for a particular day. Figure 42 illustrates these data prior to the decay, which are comparable to those of reference 1, Figure 4. These data herewith presented have a correlation coefficient of 0.68 versus 0.87 of those in reference 1. The reduced level of correlation could be due to the inclusion of cloudy days in the current investigation. Similar data for the measurements taken during the decay period are shown in Figure 43. As expected, there is considerably more scatter and the correlation is not as good. It is interesting to note that although the data are scattered, the line of best fit, forced through the origin, is very close to the ideal, indicating a random scatter.

FIGURE 43. CORRELATION OF MEASURED AND PREDICTED MIXING HEIGHT DURING COLLAPSE

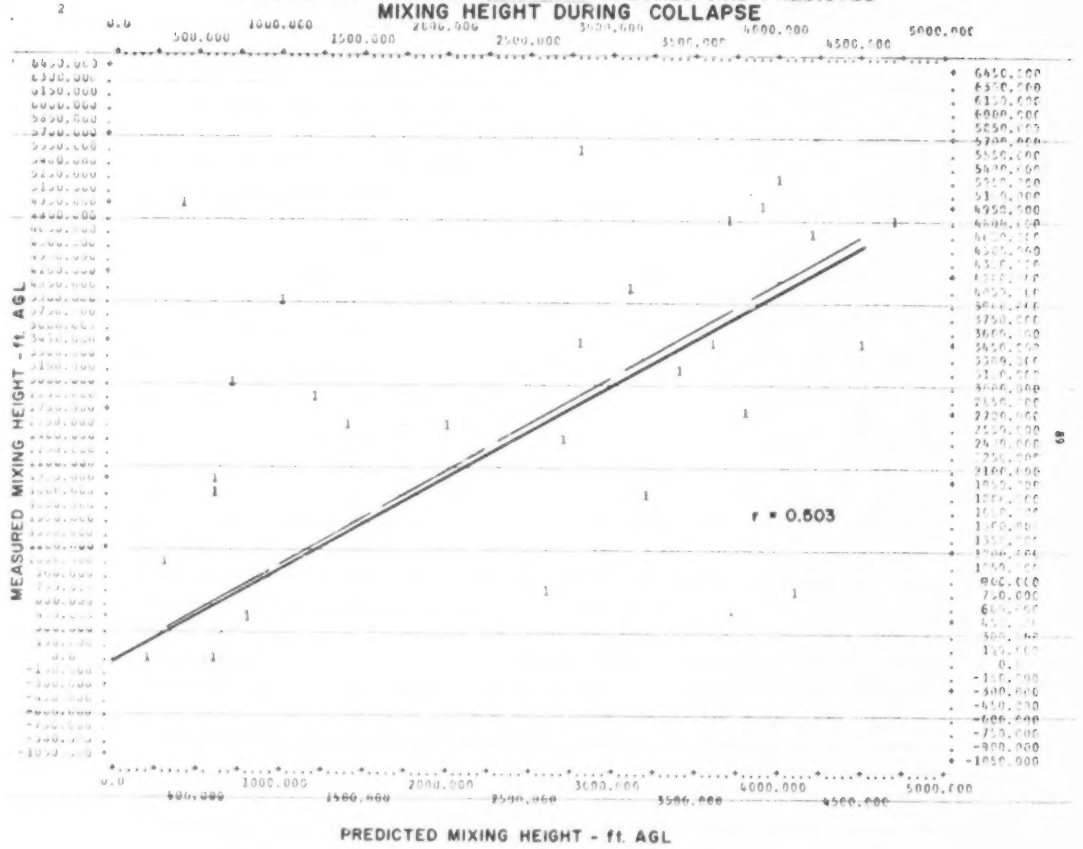


FIGURE 42. CORRELATION OF MEASURED AND PREDICTED MIXING HEIGHT PRIOR TO COLLAPSE

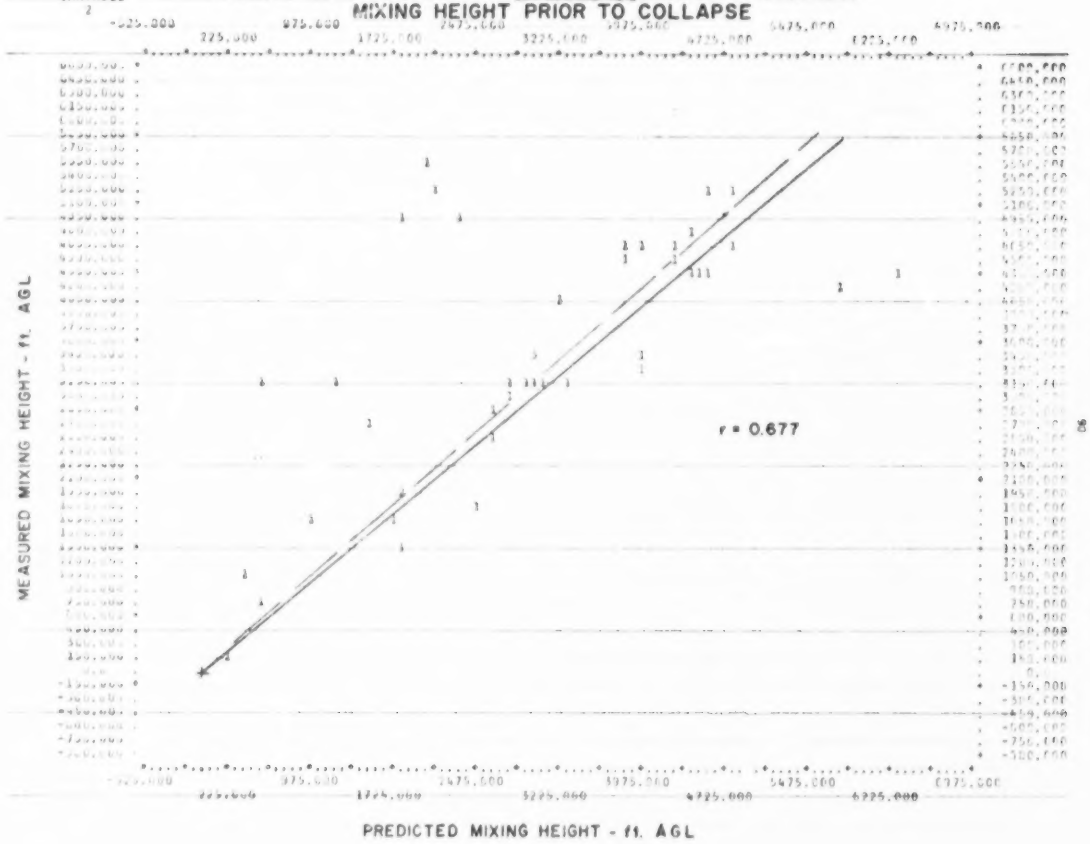


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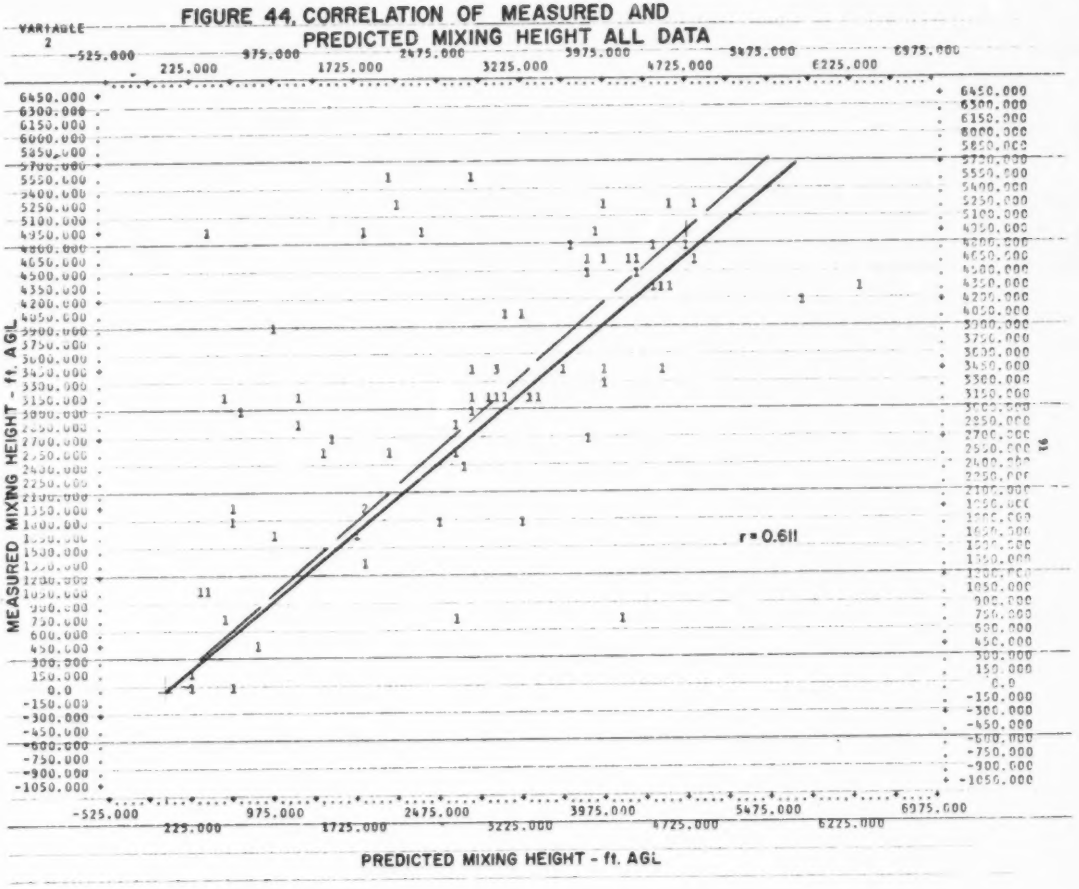
FIGURE 44. CORRELATION OF MEASURED AND PREDICTED MIXING HEIGHT ALL DATA



DIURNAL MAXIMA OF TURBULENCE, TEMPERATURE AND MIXING

In an effort to better understand the interrelationships of surface temperature, turbulent mixing height and turbulence indicator, Table II was prepared which lists the hour at which each of these parameters reached its peak on the test days.

Surface temperature peaked at an earlier hour than turbulent mixing height on six out of twelve days, the inverse happening on three days, the inverse happening on three out of twelve. The above six days were distributed among various degrees of cloud cover. The data suggests a delayed reaction of mixing height to surface temperature but is not conclusive.

Turbulence indicator peaked at an earlier hour than surface temperature on nine out of twelve days, the inverse happening on two occasions each of which had significant cloud cover.

Turbulence indicator peaked at an earlier hour than turbulent mixing height on twelve out of twelve days. Generally the time separations were significant.

These combinations suggest that the time progression of peaking events is turbulence indicator, surface temperature and finally turbulent mixing height. The time differential between the latter two is less distinct. Radiant energy data on several of these experimental days were available. Review of these data indicates that both all wavelength and short wave radiant energy peaked at approximately the same

hour as turbulence indicator. Considering that the majority of this turbulence is considered to be a redistribution of radiant energy, this correspondence would seem reasonable. It is difficult to reason the delay in surface air temperature increase. The delay in peaking of turbulent mixing height can be explained on the basis of time required for the heated air cells to complete their rise and resulting establishment of the upper limit of mixing height.

TABLE II

TIMES OF MAXIMUM PARAMETER INDICATION

DATE	TEMPERATURE	MIXING HEIGHT	TURBULENCE INDICATOR	CLOUD COVER	
09/13/71	1600	1800	1700	.5	
09/14/71	1700	1700	1500	0	
03/24/71	1700	1600	14-1500	0-.2	
03/18/71	1600	1700	1330	0	
11/17/70	1600	1600	1330	0	
05/31/71	1700	1600	1400	0	
01/20/71	1700	1630	1500	0	
01/21/71	1600	1600	1500	0	
05/07/71	15-1600	1600	14-1600	.2	
05/05/71	16-1700	1700	1600	.2	
05/24/71	1500	ND	ND	.4	
06/22/71	ND	ND	ND	.6-.7	Rain & Thundershowers
04/21/71	1400	16-1700	1100	.6	
06/04/71	1200	1500	1300	.7-.8	
06/15/71	ND	ND	ND	.8-1.0	Thunderstorms

ND - Not Well Defined

CONCLUSIONS

Atmospheric turbulence as measured by the turbulence indicator described herein undergoes an orderly buildup during the morning and early afternoon hours and experiences a rapid decay throughout its active height in the hours preceding sunset.

Turbulent mixing height as measured with an aircraft yaw accelerometer system also experiences an orderly buildup to a maximum and with the approach of sunset undergoes a rapid collapse and might be better described as rapidly losing its identity insofar as defining an upper limit.

The total turbulent energy within the mixing height attains a maximum level at a time prior to the attainment of a maximum in turbulent mixing height or surface temperature.

During the period of decay or collapse in turbulence and turbulent mixing height, there is a trend in the lapse rate toward a more stable condition, however not in proportion to the total decay or collapse in mixing.

* U.S. Government Printing Office: 1973--746-769/4163 Region No. 4